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PROPERTIES AND USES OF SHALES AND CLAYS, SOUTH-CENTRAL PENNSYLVANIA

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Kenneth J. Liles planned and supervised the test work done at the Tuscaloosa Research Center in Tuscaloosa, Alabama. He performed evaluations of the raw materials for potential uses based upon the results of the test work done in that laboratory. He also provided data for use in the preparation of the section concerning test procedures. (See additional acknowledgements on page 3.)

PROPERTIES AND USES OF SHALES AND CLAYS, SOUTH-CENTRAL PENNSYLVANIA

by Bernard J. O'Neill, Jr., and John H. Barnes
Pennsylvania Geological Survey

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PREFACE

Pennsylvania has ranked high among the states for many decades in the production of clay and shale raw materials for use in the manufacture of structural clay products, refractories, cement, lightweight aggregate, filler materials, and stoneware. The Pennsylvania Bureau of Topographic and Geologic Survey within the Department of Environmental Resources has long been a supporter of the active clay-shale mineral industry in the Commonwealth and is always ready to foster further development within this industry. To achieve these objectives, the Bureau plans and implements geologic investigations which are designed to aid those who are in search of sources of clay-shale raw materials for one or more uses. This report, covering the region of south-central Pennsylvania, presents the results obtained from one of those investigations as a cooperative effort between the Pennsylvania Bureau of Topographic and Geologic Survey and the U. S. Bureau of Mines.

The data in this report should be of particular interest to mining companies that are facing: (1) predictable exhaustion of reserves of clay-shale raw materials; (2) encroachment by other land uses; or (3) difficult zoning regulations. This report should also be of interest and benefit to land use planners, federal and state agencies, individual land owners, and all others who are interested in clay-shale raw materials.

We hope that the information in this report will contribute significantly to the further development of the clay-shale mineral industry in south-central Pennsylvania.

ARTHUR A. SOCOLOW



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(in pocket)

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PROPERTIES AND USES OF SHALES AND CLAYS, SOUTH-CENTRAL PENNSYLVANIA

by

Bernard J. O'Neill, Jr.,¹ and John H. Barnes

ABSTRACT

One hundred forty-three samples of shales and clays from 10 counties in the southwestern half of the Appalachian Mountain section of the Valley and Ridge province in Pennsylvania (Bedford, Blair, Centre, Fulton, Huntingdon, Juniata, Mifflin, Perry, Snyder, and Union Counties) were collected from 14 stratigraphic units. The samples were tested for (1) unfired properties, such as water of plasticity, drying shrinkage, workability, dry strength, and pH; (2) fired properties, such as color, hardness, total shrinkage, absorption, apparent porosity, bulk density, firing range, bloating characteristics, and pyrometric cone equivalent (when appropriate); (3) major- and minor-oxide content; and (4) mineralogic composition based on semiquantitative estimates from X-ray diffraction. Preliminary evaluations of the use potential of each raw material are also presented. An attempt was made to correlate potential uses with stratigraphic units and, based on this, certain formations are designated as possible exploration targets. Two thirds of the deposits studied were designated as potentially useful as raw material for building brick. The only material showing potential for use as a refractory or in whiteware or sanitaryware is a residual clay from the Gatesburg Formation, and two samples of the 16 evaluated from the Reedsville Formation are indicated as promising lightweight aggregate.

INTRODUCTION

A cooperative program to evaluate shales and clays in Pennsylvania for their potential uses was started in 1962 between the Bureau of Topographic and Geologic Survey, now within the Pennsylvania Department of Environmental Resources, and the U. S. Bureau of Mines within the U. S. Department of the Interior. Under this program, the Bureau of Topographic and Geologic Survey was responsible for the planning and execution of the geologic field work, the collection of samples, the determination of the mineralogy of the samples by X-ray diffraction, and the chemical analyses of the samples. The U. S. Bureau of Mines was responsible for performing the physical and firing tests and for making preliminary evaluations of the

Retired.

potential uses for each sample. Personnel at the U. S. Bureau of Mines Eastern Field Operations Center, located in Pittsburgh, Pennsylvania, co-ordinated their contributions to this program and administered the funding of costs incurred by their organization.

Phase I of the program was a statewide reconnaissance during the early 1960's that resulted in the collection and testing of 151 samples from 41 counties and 51 geologic units. Sixteen of those samples were from Bedford, Blair, Fulton, Huntingdon, Juniata, and Perry Counties, which are within the region designated as south-central Pennsylvania.¹ The results of that work were published by the Bureau of Topographic and Geologic Survey as Mineral Resource Report 51 (O'Neill and others, 1965).

Phase II of the program concentrated on the clays and shales in south-eastern Pennsylvania, where 159 samples from 15 counties and 19 geologic units were evaluated. The results of that work were published by the Bureau of Topographic and Geologic Survey as Mineral Resource Report 63 (Hoover and others, 1971).

Phase III of the cooperative program focused on the clays and shales in southwestern Pennsylvania, where 413 samples from 12 counties and 42 different stratigraphic intervals within 15 different geologic formations or groups were evaluated. The results of that work were published as Bureau of Topographic and Geologic Survey Mineral Resource Report 77 (O'Neill and Barnes, 1979).

Phase IV was the last part of the planned cooperative program and concentrated on south-central Pennsylvania. During this phase, 143 shale or clay samples were collected and submitted to the U. S. Bureau of Mines Tuscaloosa Research Center in Tuscaloosa, Alabama, where tests were performed to determine the physical and firing properties of the samples and to make preliminary evaluations of the potential use of the material. The results of these tests together with the following information for each sample are presented in this report: (1) the location is shown on the geologic map (Plate 1), and reported by latitude and longitude; (2) the geologic unit from which it was collected is identified; (3) the stratigraphic thickness it represents is recorded; (4) the results of the physical and firing tests are reported; (5) semiquantitative estimates of mineralogy are reported; (6) atomic absorption major- and minor-oxide analyses are listed; and (7) preliminary evaluations of potential uses are presented.

Numerous reports concerned with the clays and shales of Pennsylvania have been published by the Pennsylvania Bureau of Topographic and Geologic Survey and the U. S. Geological Survey. Six that are recommended for additional background material on raw materials in south-central Pennsylvania are those by Hosterman (1972), Leighton (1934, 1941), Moore (1922),

¹ South-central Pennsylvania, as defined for this report, includes the following 10 counties: Bedford, Blair, Centre, Fulton, Huntingdon, Juniata, Mifflin, Perry, Snyder, and Union.

O'Neill and others (1965), and Shaw (1928). Additional reports on this subject are included in the list of references.

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The contributions of the U. S. Bureau of Mines during this cooperative study are gratefully acknowledged. Robert D. Thomson, Chief of the Eastern Field Operations Center, located in Pittsburgh, Pennsylvania, was responsible for administering the funding of costs incurred by the U. S. Bureau of Mines. William Coehran, Allan T. Schmidt, Robert E. Brown, and Charles T. Chislighi in that office were most helpful in coordinating this joint project between state and federal agencies. Chislighi assisted in the preparation of the section in this report concerning clay-shale production.

Kenneth J. Liles planned and supervised the test work performed on the clay-shale samples at the U. S. Bureau of Mines Tuscaloosa Research Center in Tuscaloosa, Alabama. He also performed preliminary evaluations of the samples for potential uses, based on the test results, and provided data for use in the section in this report concerning the test procedures.

Robert C. Smith, II, our colleague in the Mineral Resources Division, provided invaluable assistance in the planning and execution of the atomic absorption analytical procedures used to determine the chemistry of the clay-shale samples. He also interpreted most of the atomic absorption data and provided assistance in reviewing this report. He and many of our colleagues in the Geologic Mapping Division of the Bureau provided many of the samples analyzed in this project, or indicated localities from which samples could be obtained.

Appreciation is due also to Arthur A. Socolow, State Geologist of Pennsylvania, for his continued interest and advice during the various phases of this project.

GEOLOGIC SUMMARY FOR SOUTH-CENTRAL PENNSYLVANIA

LOCATION

South-central Pennsylvania, as defined for this report, consists of the 10 counties shown in Figure 1. Listed alphabetically, these counties are Bedford, Blair, Centre, Fulton, Huntingdon, Juniata, Mifflin, Perry, Snyder, and Union.

The important metropolitan area around Altoona, which had a population of about 133,400 in 1975, according to the Pennsylvania Department of Commerce (1978, p. 22), is located in the west-central part of south-central Pennsylvania in Blair County.

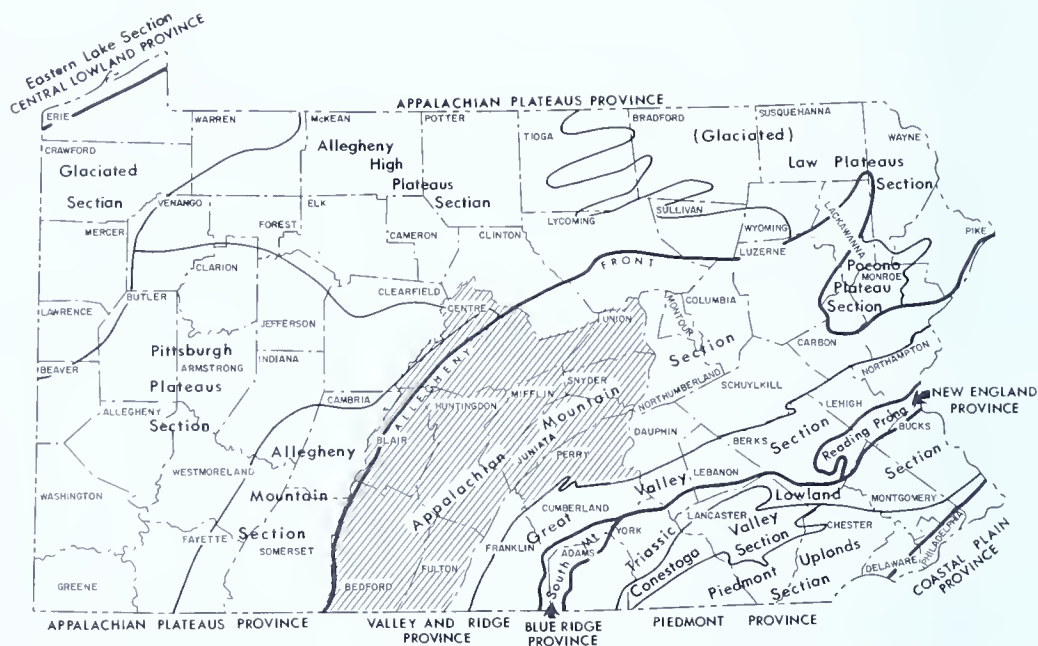


Figure 1. Map of the physiographic provinces of Pennsylvania showing the region of south-central Pennsylvania.

The boroughs of State College and Lewistown are the only other municipalities in south-central Pennsylvania having a population exceeding 10,000 in 1975 (Pennsylvania Department of Commerce, 1978, p. 19, 20).

PHYSIOGRAPHY

Pennsylvania is divided into seven physiographic provinces, as shown in Figure 1. Three of these physiographic provinces are subdivided into sections. South-central Pennsylvania lies primarily within the Appalachian Mountain section of the Valley and Ridge province. The areas of south-central Pennsylvania that lie outside the Appalachian Mountain section occur within the Appalachian Plateaus province and are found in the western or northwestern parts of Bedford, Blair, and Centre Counties. The Appalachian Plateaus province is separated from the Valley and Ridge province by the Allegheny Front. The margin at the Front is abrupt and distinct in many places because erosion, gradually wearing back the Plateau rocks from the east, has resulted in a steep erosional escarpment.

The Appalachian Mountain section of the Valley and Ridge province is characterized by a marked parallelism of ridges and valleys, commonly trending in a northeast-southwest direction. The landforms in this section are closely related to differences in resistance to erosion of the various lithologies and to the structure of the folded bedrock. The ridges and valleys represent the relative difficulty of erosion of hard and soft rocks. In gen-

eral, the ridges are formed of hard quartzites and sandstones that resisted erosion, whereas the valleys are underlain by the softer shales and limestones. The major source areas for shales in south-central Pennsylvania are the generally well rounded, smooth, rolling hills that make up the valley floors or the lower flanks of the ridges.

The maximum relief in south-central Pennsylvania is about 1,825 feet (560 m). The highest point in this area, which is at an elevation of 3,136 feet (956 m), occurs on the Allegheny Front and is represented by Blue Knob in Union Township, Bedford County. The lowest point, at an elevation of 310 feet (94 m), occurs where the Susquehanna River leaves Perry County.

The elevations of ridges in the Valley and Ridge province in south-central Pennsylvania range from about 1,600 to 2,900 feet (490 to 880 m). The elevations of valleys in the province range from about 400 to 1,100 feet (120 to 340 m).

The drainage pattern within the Valley and Ridge province is a reflection of the adjustment to geologic structure and type of lithology. In general, streams follow the longitudinal northeast-southwest strike of the softer rocks in the valleys, but at some points they cross the hard belts of rock, forming "water gaps." This combination of longitudinal and transverse trends of the streams results in a trellis-like drainage pattern.

The Appalachian Plateaus province occurs west of the Valley and Ridge province and is separated from it by the Allegheny Front (Figure 1). It is underlain by flat-lying to mildly folded sedimentary rocks that have been highly dissected by streams. The major streams and intricately branching tributaries form a dendritic drainage pattern that has carved the plateau into a maze of steep-sided valleys. These valleys are now about 400 to 500 feet (120 to 150 m) below the uplands.

Exceptions to the general topography occur in the Allegheny Mountain section of the Appalachian Plateaus province, where a number of conspicuous ridges trending northeast-southwest rise up to elevations exceeding 2,700 feet (820 m). These ridges are commonly underlain by resistant sandstone.

STRUCTURE

Structure refers to the present attitude of the sedimentary rocks. Originally deposited in a horizontal or nearly horizontal position, these rocks became folded and/or broken in places when they were subjected to movements of the earth's crust. Faulting occurred when displacement of the rocks took place along breaks.

The major structural features in the Appalachian Mountain section of the Valley and Ridge province parallel the general northeast-southwest grain of the topography. The axes of the major anticlinal and synclinal folds and the strike of the major faults follow the grain as seen on the geologic map on Plate 1.

The folding in the Appalachian Mountain section is intense, as illustrated in the cross section on Plate 1. The strata generally dip in excess of 20 degrees and are vertical in many places. Exceptions occur near the axes of folds, where dips of less than 20 degrees are common.

Many of the antiforms and synclines are slightly to markedly asymmetrical, the northwest limbs of the antiforms and the southeast limbs of the synclines being more steeply inclined than the other limbs. The larger folds are not simple, but are composed of numerous minor folds. The geologic units that are composed of many thin beds of shale and siltstone tend to be incompetent as a whole, and have responded to tectonic stresses by developing complex small-scale folding and faulting, especially along the crests and troughs of major folds.

The axial planes of most folds dip steeply. The majority of folds plunge either to the northeast or southwest, generally from 5 to 10 degrees, although plunges may be as high as 20 degrees in places. Some folds are doubly plunging folds, plunging both to the northeast and southwest.

The zigzag patterns on the geologic map on Plate 1 indicate where beds are bent around the axes of plunging antiforms and synclines. Areas around the axes of plunging folds, where underlain by a suitable interval of shale, offer attractive exploration targets because dips near the axes are relatively gentle and result in the availability of larger tonnages of reserves closer to the surface for quarrying.

A few larger scale thrust faults have been mapped in the Valley and Ridge province and are shown on the geologic map and cross section on Plate 1. Most of these faults are of the high-angle type near the surface. Faults also occur in the Appalachian Plateaus province, but are not classified as major structural features.

The Appalachian Plateaus province (Figure 1) is underlain by flat-lying to mildly folded sedimentary rocks.

A system of joints occurs in the rocks in both provinces and includes two major sets at right angles to each other. The frequency of joints varies according to rock type. In shales, joints are commonly close together, whereas in sandstone they are more widely separated. Intermediate spacing is generally found in the other rock types.

STRATIGRAPHY

The rocks exposed in south-central Pennsylvania are sedimentary types, though some are subtly metamorphosed. The original sediments were deposited in aqueous environments, both marine and nonmarine, during a geologic interval spanning from the Late Cambrian Period to the Pennsylvanian Period. Their ages are estimated to range from 500 million to 280 million years, respectively.

The rocks and weathered products represented by this sequence are not restricted to shales and clays, but include other sedimentary types such as sandstone, siltstone, conglomerate, limestone, and coal. Some of the sandstones have been metamorphosed to quartzites.

The shales and clays that have been used in the past as raw materials in the manufacture of structural clay products, or that were evaluated for potential uses during this study, are included within the following geologic units, listed in order from oldest to youngest: the Gatesburg Formation of Late Cambrian age; the Axemann and Bellefonte Formations within the Beekmantown Group of Early Ordovician age; the Reedsville Formation of Ordovician age; the Clinton Group and the McKenzie,¹ Bloomsburg, and Wills Creek Formations of Silurian age; the Oriskany Formation¹ of Early Devonian age; the Marcellus and Mahantango Formations of Middle Devonian age; the marine beds and Catskill Formation of Late Devonian age, the Mauch Chunk Formation of Mississippian age; and the Pottsville and Allegheny Groups of Pennsylvanian age.

Cambrian System

Gatesburg Formation

The Gatesburg Formation is composed principally of thin- to thick-bedded, bluish-gray, coarsely crystalline dolomite having many interbeds of sandstone. Butts and Moore (1936) calculated the proportion of dolomite to sandstone at 10 to 1 in a well-exposed section in the vicinity of Birmingham, Huntingdon County. According to Butts and others (1939), the Gatesburg Formation is about 1,750 feet (530 m) thick.

White residual clay deposits have been derived from silty dolomites within the Gatesburg Formation through the process of weathering. The clay deposits in the Gatesburg Formation are lens or oval shaped. Leighton (1934, p. 1-9) describes their distribution and development. Hosterman (1972, p. B61) interprets them as having been formed within sinkholes and caverns in the dolomitic (carbonate) rocks in the Gatesburg Formation. During a prolonged period of weathering, a residuum of weathered material formed on the dolomite. At the same time, groundwater flowed within zones of least resistance such as faults and fractures, and along the steeply dipping bedding planes in the dolomite. Where in contact with the dolomite, the groundwater dissolved the rock, with the result that caverns and sinkholes were eventually formed. The weathered material from overlying residuum washed into these sinkholes and caverns. Some of these sinkholes and caverns became so filled with weathered material, composed largely of clay, that the downward flow of water was restricted, and stagnant ponds formed

¹ In currently accepted usage, the McKenzie and Oriskany are part of the Mifflintown and Old Port Formations, respectively. Faill and Wells (1974, p. 7-130) describe the stratigraphy of south-central Pennsylvania in detail.

in the sinkhole depressions at the surface. The clayey material was leached of potassium, iron, and some silicon as water saturated with carbon dioxide (carbonic acid) and humic acid derived from organic matter in the pond slowly percolated downward through the clayey material (Hosterman, 1972, p. B61).

Ordovician System

Carbonate Rock Formations

In the valleys underlain by carbonate rocks, prolonged periods of weathering have produced residual clays at the surface ranging from a few to several tens of feet (1 to several meters) in thickness. Frequently, differential weathering of the carbonate rocks results in unweathered pinnacles of rock which protrude up into a cover of weathered clay. Rock pinnacles present problems for miners, because they must either be mined around or be removed by drilling and blasting during development of the quarry or mine.

The carbonate rock formations of Ordovician age are the Stonehenge-Larke, Nittany, Axemann, and Bellefonte within the Beekmantown Group, and the overlying Loysburg, Hatter, Benner, Curtin, Nealmont, Salona, and Coburn Formations. Except for Union and Snyder Counties, all counties in south-central Pennsylvania have Ordovician limestones or dolomite occurring at the surface in some places.

Reedsville Formation

The Reedsville Formation consists at its base of medium- to dark-gray fissile shale, which grades upward into olive-gray, thin-bedded shale and some thin interbeds of siltstone, sandstone, and fossiliferous limestone. The thickness of the Reedsville Formation is reported to range from about 825 to 1,500 feet (250 to 460 m) in south-central Pennsylvania.

Shales of the Reedsville Formation occur at the surface in some part of every county within south-central Pennsylvania.

Silurian System

Clinton Group

The Clinton Group includes the Rose Hill Formation, the Keefer Sandstone, which lies stratigraphically above the Rose Hill, and the Rochester Shale, which lies above the Keefer.

The Rose Hill Formation is the thickest sequence within the Clinton Group. Butts (1936) reported that the Rose Hill makes up about 90 percent of the Clinton. The thickness of the Rose Hill Formation in south-central Pennsylvania ranges from a minimum of 600 feet (183 m), according to Butts (1936), to about 950 feet (290 m), according to Faill and Wells (1974).

By comparison, the Keefer Sandstone is reported to be about 20 feet (6 m) thick and the Rochester Shale about 60 feet (18 m) thick.

The Rose Hill Formation consists primarily of olive- to medium-gray, thin-bedded shale interbedded with some grayish-red to purple shale, olive-gray siltstone, and fine-grained sandstone. Two grayish-red, medium-grained, thick-bedded, highly ferruginous sandstones occur locally within the Rose Hill. One occurs about 115 to 150 feet (35 to 45 m) from the upper contact; the second about 525 to 590 feet (160 to 180 m) below that contact.

The Rochester Shale is essentially fissile to thin-bedded, gray shale that includes some interbeds of gray, crystalline, fossiliferous limestone and, in some places, a thin layer of gray calcareous sandstone or arenaceous limestone.

Shales of the Clinton Group occur in parts of each of the 10 counties within south-central Pennsylvania.

McKenzie Formation

The McKenzie Formation of Silurian age consists predominantly of medium- to dark-gray, thin- to medium-bedded, fossiliferous limestone that has intervals and interbeds of greenish-gray shale. The thickness of the McKenzie is reported to range from about 200 to 350 feet (60 to 110 m). It occurs in parts of each of the 10 counties within the region of south-central Pennsylvania.

Bloomsburg Formation

The Bloomsburg Formation of Silurian age consists primarily of grayish-red claystone and shale and subordinate amounts of siltstone and fine-grained sandstone. Locally some thin impure limestone and green shale are found in the sequence. The thickness of the Bloomsburg ranges from about 350 to 500 feet (110 to 150 m). It occurs in parts of each of the 10 counties within the study region.

Wills Creek Formation

The Wills Creek Formation of Silurian age consists of a number of sedimentary rock types that are extensively interbedded in places. Conlin and Hoskins (1962) and Miller (1961) were able to distinguish several members within the Wills Creek. The upper member, ranging in thickness from 170 to 200 feet (52 to 61 m) is composed of medium-gray to greenish-gray, thin-bedded calcareous shale containing interbeds of greenish-gray, thin- to medium-bedded calcareous siltstone and, locally, some beds of grayish-red silty shale. The lower member, which has a thickness of about 450 feet (140 m), consists of a sequence of interbedded grayish-red, olive, and olive-gray calcareous shale, siltstone, and very fine grained sandstone. Thin limestone beds occur throughout the entire formation.

Thicknesses reported for the Wills Creek Formation in south-central Pennsylvania range from about 500 to 800 feet (150 to 240 m). The Wills Creek Formation occurs in parts of each of the 10 counties within the region of south-central Pennsylvania.

Devonian System

Oriskany Formation

The Oriskany Formation of Early Devonian age consists of white to brown, fine- to coarse-grained, partly calcareous, locally conglomeratic, fossiliferous sandstone in the upper portion and dark-gray, cherty limestone interbedded with some shale and sandstone in the lower portion (Gray and others, 1960).

In places the Oriskany Formation weathers to form masses of white to gray clay. Leighton (1934, p. 9-12) described three localities in Huntingdon County where white clays from the Oriskany Formation have been worked.

Hosterman (1972, p. B61) attributes the origin of these clay deposits to the alteration of the cherty, limy shale in the Oriskany Formation. This alteration is the result of intense leaching of downward-percolating groundwater through the rock, which leaves behind a residue of white clayey silt.

The thickness of the Oriskany as reported by Leighton (1934, p. 9) is 300 feet (91 m).

Marcellus Formation

The Marcellus Formation makes up the lower part of the Hamilton Group of Middle Devonian age. It consists primarily of a distinctive, fissile, dark-gray to black, carbonaceous shale in the lower portion, generally ranging from 75 to 100 feet (23 to 30 m) in thickness. Stratigraphically above this fissile shale is an olive to dark-gray, medium- to thick-bedded, fine- to medium-grained sandstone sequence which may be from 65 to 145 feet (20 to 44 m) thick. The upper part of the Marcellus is represented by a sequence of dark-gray to black silty shale and fine-grained sandstone that ranges from about 75 to 125 feet (20 to 40 m) in thickness.

The thickness for the Marcellus Formation, as reported for south-central Pennsylvania, ranges from about 215 to 400 feet (70 to 120 m). The Marcellus Formation occurs at the surface in places within each of the 10 counties within the region of south-central Pennsylvania.

Mahantango Formation

The Mahantango Formation lies stratigraphically in the upper part of the Hamilton Group of Middle Devonian age. It is composed of interbedded shale, claystone, siltstone, and sandstone which are predominantly light olive gray to olive gray and dark yellowish brown. Butts and others (1939), Dyson (1967, 1963), Miller (1961), and Faill and Wells (1974), all working

within different quadrangles in this region, subdivided the Mahantango Formation into different members based upon differences in lithology. Some of these subdivisions consist predominantly of shales, and also claystones containing interbeds of siltstone.

The thickness of the Mahantango ranges from about 900 up to a possible maximum of 2,600 feet (270 to 790 m). It is found at the surface in parts of every county within south-central Pennsylvania.

Devonian Marine Beds

The Devonian marine beds occur stratigraphically above the Mahantango Formation and are of Late Devonian age. They consist of shale, siltstone, and sandstone, but the many thick sequences of shale predominate within the stratigraphic sequence. The Devonian marine beds crop out in parts of every county within south-central Pennsylvania. The geologic units within the Devonian marine beds from which samples were collected and tested for this study are described below. The units are listed in order of relative age from oldest to youngest.

Burket Member of Harrell Formation. The Burket Member of the Harrell Formation is composed of dark-gray to grayish-black, fissile shale and a few interbeds of olive-gray to dark-gray siltstone and sandstone. Its thickness is reported to range from about 50 to 200 feet (15 to 60 m).

Harrell Formation. The Harrell Formation consists predominantly of gray to olive-green shale and silty shale, much of which is fissile and relatively soft. The Harrell ranges in thickness from about 100 to 250 feet (30 to 80 m) in south-central Pennsylvania.

Brallier Formation. The Brallier Formation is predominantly a pale- to dark-green arenaceous shale, much of it consisting of thin laminae. The thickness of the Brallier is reported to range from about 975 to 1,800 feet (300 to 550 m).

Trimmers Rock and Brallier Formations, Undivided. The Trimmers Rock-Brallier unit is composed largely of medium-dark-gray, fine-grained sandstone, siltstone, and shale. Shale and siltstone are dominant in the lower part and sandstone dominates in the upper part. The lowest portion of the unit is typical shaly Brallier lithology. Dyson (1967) reported that the Trimmers Rock-Brallier ranges in thickness from 975 to 2,000 feet (297 to 610 m).

Catskill Formation

The Catskill Formation lies stratigraphically above the Devonian marine beds and is Late Devonian in age. It consists chiefly of grayish-red to brownish-red shale, claystone, siltstone, and sandstone. Thin layers of gray

and greenish shale and sandstone occur in the sequence. Butts and Moore (1936) estimated that they constitute about 20 percent of the total thickness.

The Catskill Formation is characterized by cyclic sedimentation and rapid lithologic changes both laterally and vertically. Dyson (1967) reported that some units that are several hundred feet(?) thick can be traced laterally only a very short distance.

The Catskill Formation has been subdivided into various members. Dyson (1967) defined four members—the Duncannon, Clarks Ferry, Sherman Creek, and Irish Valley—in the southern half of the New Bloomfield 15-minute quadrangle.

The total thickness for the Catskill Formation, as interpreted from geologic reports covering south-central Pennsylvania, ranges from about 3,500 to more than 8,800 feet (1,070 to more than 2,680 m).

The Catskill Formation is at the surface in parts of all counties in south-central Pennsylvania except Mifflin County.

Mississippian System

Mauch Chunk Formation

The Mauch Chunk Formation consists essentially of interbedded grayish-red shale, siltstone, and fine- to medium-grained sandstone. Some thin green shale occurs in places throughout the section. Gray to greenish sandstone occurs in the lower part along with some conglomerate.

Dyson (1967) estimated the thickness for the Mauch Chunk Formation as probably greater than 5,000 feet (1,520 m) in the southern half of the New Bloomfield 15-minute quadrangle.

The Mauch Chunk is mapped at the surface in six of the 10 counties within south-central Pennsylvania; it is absent in Juniata, Mifflin, Snyder, and Union Counties.

Pennsylvanian System

Pottsville and Allegheny Groups

The Pottsville and Allegheny Groups of Pennsylvanian age occur at the surface: (1) in Bedford, Fulton, and Huntingdon Counties, where they are part of the Broad Top coal field; (2) along the northwestern part of Centre County and the western part of Blair County, where they occur northwest of the Allegheny Front within the Allegheny Plateaus province; and (3) in a small area located north of Hyndman in Bedford County.

Pottsville Group. The Pottsville Group, which stratigraphically underlies the Allegheny Group, consists predominantly of sandstone and conglomerate and subordinate amounts of thin shale, coal, and underclay. The underclays, in particular those beneath the Mercer and Brookville coals, offer the only potential as sources of clay-shale raw materials in this group.

The Pottsville Group is only partially exposed in most of the quadrangles that have been mapped in south-central Pennsylvania. However, Butts (1945) reported that the total thickness for the Pottsville Group ranges from 130 to 300 feet (40 to 91 m) in the Hollidaysburg-Huntingdon quadrangles in Blair and Huntingdon Counties.

Allegheny Group. The Allegheny Group of Pennsylvanian age occurs stratigraphically above the Pottsville Group and consists of cyclic-like sequences of shale, siltstone, and sandstone, and subordinate amounts of coal and underlay. The important lithologies considered in this study are the under-clay and shale.

Glass (1972), mapping in the Philipsburg quadrangle in Centre and Clearfield Counties, reported that the Allegheny Group ranges in total thickness from 270 to 315 feet (82 to 96 m).

CLAY-SHALE PRODUCTION IN SOUTH-CENTRAL PENNSYLVANIA

Production of clay and shale raw materials from south-central Pennsylvania since 1960 has come from five of the 10 counties within the region: they are Blair, Centre, Huntingdon, Snyder, and Union. From 1960 through 1977, fire clays and miscellaneous clays were produced; during the period from 1960 through 1967, kaolin also was produced.

Fire clay, which has been produced in Blair, Centre, and Huntingdon Counties, has been used in the manufacture of refractory brick and block. Miscellaneous clay, from Snyder and Union Counties, has been used in the manufacture of structural clay products. Kaolin, quarried in Blair County, was used in the manufacture of ceramics, refractories, and paper.

The annual production and dollar value for the clay-shale raw materials extracted from the 10 counties of south-central Pennsylvania have never exceeded 5 percent of the production recorded for the Commonwealth, though the counties make up 13 percent by area. The rank of dollar value of clay-shale materials, compared to all mineral commodities produced within the five counties in south-central Pennsylvania that produced clay-shale raw materials between 1960 and 1975, is shown in Table 1.

Figure 2 shows the general trends of production and dollar values for the clays and shales used or sold in south-central Pennsylvania during the period from 1960 through 1977.

The production in tonnage and dollar value recorded for clays and shales sold or used in the Commonwealth during the period from 1960 to 1977 is shown in Figure 3. A comparison of the trends shown in Figure 2 against those shown in Figure 3 indicate that the pattern developed in the past for clay-shale production in south-central Pennsylvania is quite different from

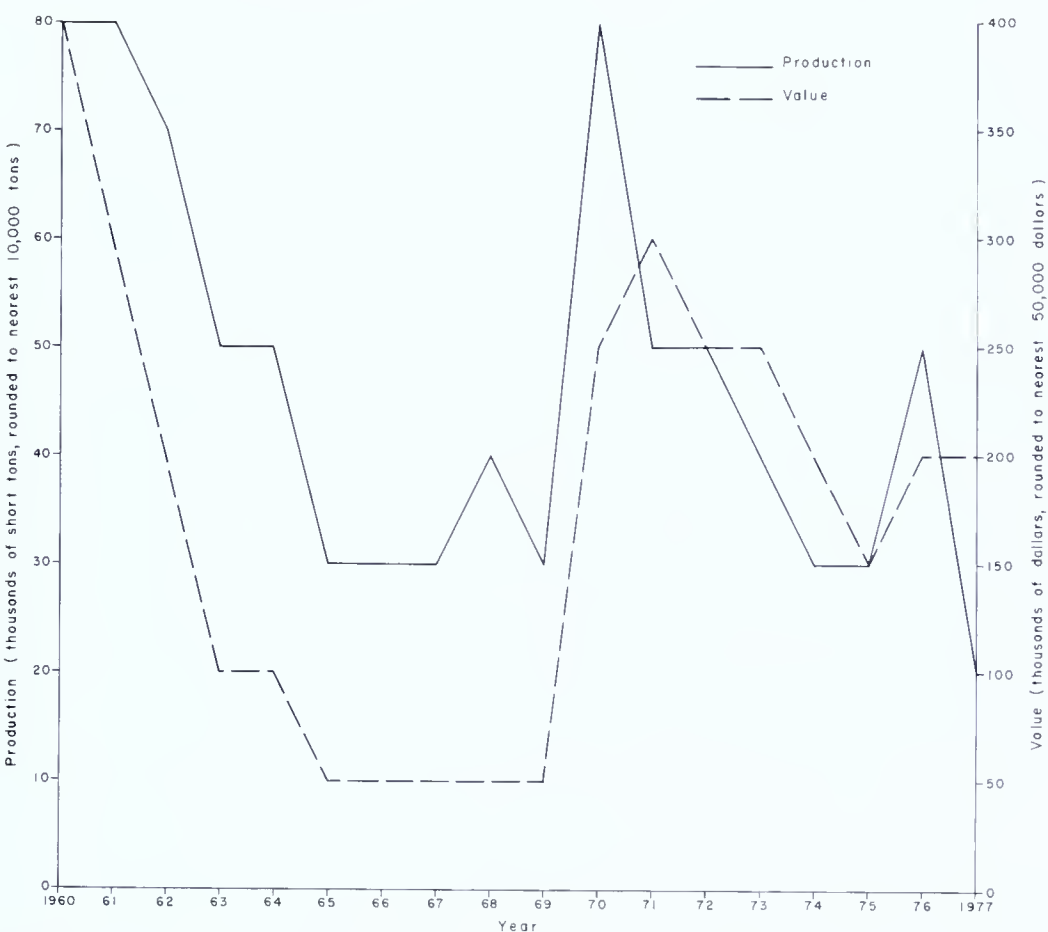


Figure 2. Tonnage and dollar values for shales and clays used or sold in south-central Pennsylvania, 1960-1977. Tonnages are rounded to the nearest 10,000 short tons; dollar values are rounded to the nearest 50,000 dollars. One short ton equals 0.9 metric ton.

the one developed in the Commonwealth as a whole. For example, clay-shale production in south-central Pennsylvania reached a high range in 1960, whereas production in the Commonwealth peaked in 1965. Likewise, the dollar value for clays and shales in south-central Pennsylvania reached a high range in 1960, whereas the dollar value for the Commonwealth reached a peak in 1969. In addition, clay production in south-central Pennsylvania dropped to a low range during the years from 1965 through 1969, whereas clay production for the Commonwealth fell to a low in 1975. Also, the lowest range for dollar values from clay production in south-central Pennsylvania occurred from 1965 through 1967, 1969, 1974, 1975, and 1977, whereas the lowest dollar value for clays and shales in the Commonwealth was reached in 1962.

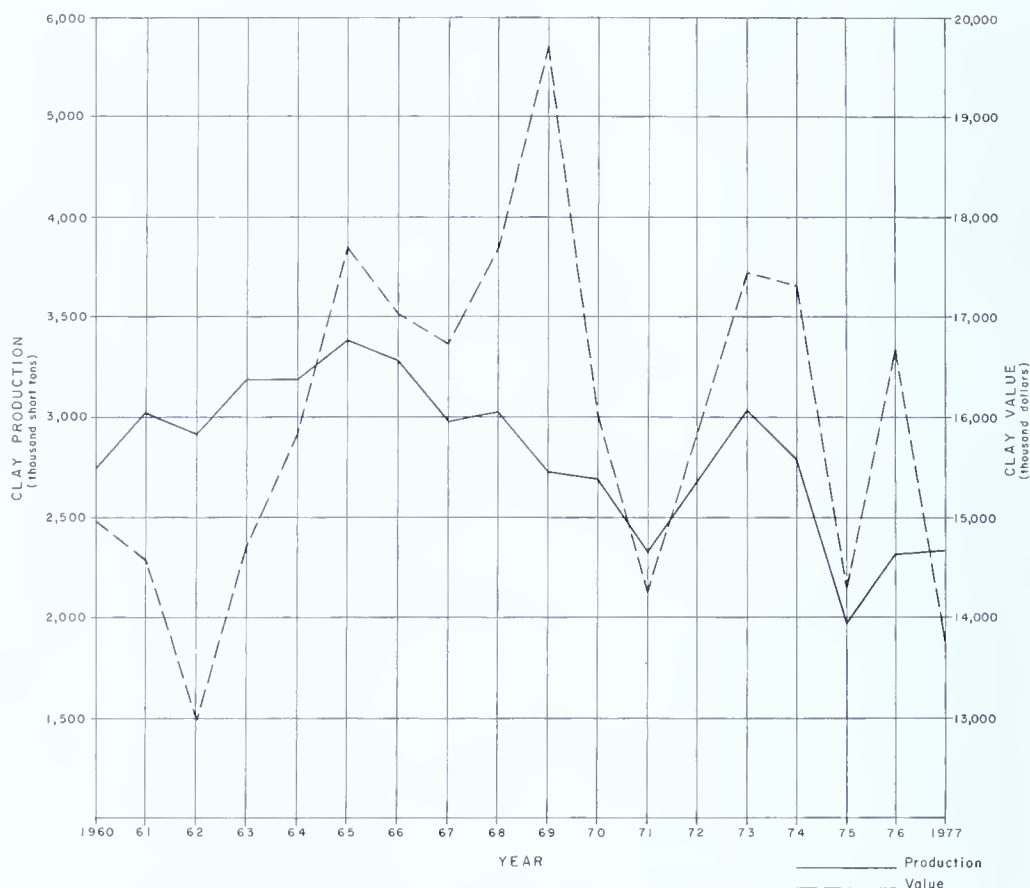


Figure 3. Pennsylvania clay-shale production and value, 1960-1977.

SAMPLING AND TESTING PROCEDURES

GENERAL STATEMENT

The primary purpose of this study was the evaluation of clay and shale samples collected from as many geologic formations as possible in south-central Pennsylvania. A total of 143 samples from 14 geologic formations or groups was collected by the staff of the Pennsylvania Bureau of Topographic and Geologic Survey. These samples were submitted to the Tuscaloosa Research Center of the U. S. Bureau of Mines in Tuscaloosa, Alabama, where physical and firing tests were performed and preliminary evaluations were made as to potential use. The sampling and testing procedures followed during these phases of the study are described below.

SAMPLING TECHNIQUES

Samples were collected from natural exposures, roadcuts, quarries, and coal strippings. The minimum weight for each sample was 10 pounds (4.5

kg). Whenever possible, a channel sample of the clay-shale material was collected. Where conditions precluded channel sampling, a representative sample or a grab sample was obtained. Each sample location was assigned a number and plotted on a 7-1/2-minute topographic map for the reference file, and notes were made describing the sampled material and its geologic environment. The locations for the 143 shale and clay samples are shown on Plate 1. The detailed description for each sample is included in the "Sample Data and Test Results" section of this report.

TESTING PROCEDURES

The wide variety of products made from industrial shales and clays classifies them as a major industrial raw material. Many clays and shales can be used in the crude state, but others must be beneficiated or refined to remove objectionable impurities. For each use, the raw material must possess certain properties, and what is considered to be a critical property in a shale or clay for one product may be wholly unimportant in another. To test each sample for all uses would be impractical, and, fortunately, is unnecessary for preliminary appraisals. The preliminary testing is exploratory and gives clay type and physical properties. Such evaluations are valuable in that they identify specific sites where further test work on promising clay-shale raw materials is warranted. The procedure for preliminary testing followed by the U. S. Bureau of Mines Tuscaloosa Research Center is as follows:

A 10-pound (4.5-kg) sample of the material is dried at 221°F (105°C) and ground to pass a 3/4-inch- (2-cm-) mesh sieve. A 2-pound (1-kg) split is then crushed to pass 20 mesh. One pound (500 g) of the powdered material is tempered with water to form a plastic mass. The water of plasticity and workability are noted. Small test briquets (1 x 2 x 3/8 inch, or 2.5 x 5 x 1 cm) are extruded, and, after being marked for shrinkage, are dried for 24 hours, then oven dried at 221°F (105°C) an additional 24 hours. The color, drying shrinkage, and dry strength are noted. The dried specimens are then placed in an electric laboratory kiln. The temperature is raised, using a 24-hour cycle, to 1832°F (1000°C), and remains at that temperature for a 1-hour soak period. The briquet is then allowed to cool slowly in the kiln. Replicate briquets are subsequently fired to temperatures of 1922°F (1050°C), 2012°F (1100°C), 2102°F (1150°C), 2192°F (1200°C), and 2282°F (1250°C), with a 1-hour soak at each maximum temperature. After cooling, the linear shrinkage is noted. The briquets are then weighed and immersed in boiling water for 5 hours. They are then reweighed, first in air, then in water. From these weights the percent absorption, percent apparent porosity, and bulk density are calculated. Finally, each briquet is redried at 221°F (105°C) and Mohs' hardness and the Munsell color are determined, following ASTM specifications. If a material shows potential for use in structural clay products, it is further tested after either extrusion or dry pressing (Liles and Heystek, 1977).

Thirty-five hundredths (0.35) ounce (10 g) of the minus-20-mesh material is mixed with 3.38 fluid ounces (10 mL) of distilled water and the pH of the slurry is determined. Thirty-four hundredths (0.34) fluid ounce (10 mL) of concentrated HCl is added to this slurry to qualitatively assess the degree of effervescence.

Some of the 3/4-inch (2-cm) pieces of the sample are randomly picked and used for a quick-fire test to determine bloating characteristics. The sample is placed in a preheated kiln at 2012 °F (1100 °C). If there is any sign of expansion, additional tests are made over a wider range of temperatures, and the percent absorption and bulk density are determined for each temperature (Liles and Heystek, 1977).

From the preliminary tests, the following data are collected: characteristics of the unfired material, including color, pH, water of plasticity, drying shrinkage, and dry strength; and characteristics of the fired material, including total shrinkage, color, hardness, absorption, apparent porosity, bulk density, and bloating tendency.

As a rule, the information obtained from the preliminary tests constitutes a starting point in appraisal of the material. The information does not suffice for plant or process design, nor does it preclude the use of the material in mixes.

CRITERIA USED IN EVALUATING CLAYS AND SHALES

STRUCTURAL CLAY PRODUCTS

Structural clay products are commonly formed by stiff-mud extrusion. The ideal clay or shale should have moderate plasticity and good workability, high dry strength, a long vitrification temperature range, total shrinkage of less than 10 percent, and a fired color that will meet market specifications. Because few clays or shales are ideal in all properties, it is often necessary for the manufacturer to develop blends fitted to his process and product.

REFRACTORY CLAYS

The most important property to be considered in appraising refractory clays is their capacity to endure high temperatures. Other properties must be considered but vary in importance with the method of fabrication and the specific use. Blends of clays are used in making most refractory products, and the ware can be formed by dry pressing, extruding, casting, or hand molding. The desirable properties of the blending materials, such as plasticity, green strength (wet and dry), and drying characteristics, will also vary to some extent, depending on the method of fabrication used.

Some of the more common names associated with refractory clays are flint, semiflint, semiplastic, plastic, high-alumina, coal-measure fire clays, and refractory bond clays. Such names as "high duty," "intermediate duty" or "moderate duty," and "low duty" are used by the trade to indicate the class of refractory.

In a preliminary evaluation of a refractory clay, the general testing procedure distinguishes the plastic clays from the nonplastic clays and gives other properties such as shrinkage, absorption, and apparent specific gravity. The most essential test for these clays is the pyrometric cone equivalent (PCE) test. This test will distinguish refractory clays from nonrefractory materials and also indicate the maximum temperature at which the clay can be used.

The criteria given in this report for appraising the refractory clays are based largely on the pyrometric cone equivalents shown in Table 2.

Table 2. Standard Classification of Fireclay Refractory Brick as Proposed by A.S.T.M. C27-70

Class	Pyrometric cone equivalent	Temperature (°C) (A.S.T.M. C24-72)
Super duty	33	1743
High duty	31 1/2-32	1699-1717
Intermediate duty	29 -31	1659-1683
Low duty	15 -28	1430-1646

LIGHTWEIGHT AGGREGATE

The process of expanding clays and shales in a rotary kiln to produce lightweight aggregate for concrete was patented by Stephen Hayde in 1917; however, demand for the product was limited and the industry did not begin to expand until the construction boom following World War II. From 1974 through 1976, however, a decrease in consumption had occurred to the point where only about 6.2 million tons of lightweight aggregate from clays and shales was manufactured in 1976.

In the early years, control over the raw materials and the processing was minimal; as a result, much of the aggregate entering the market was of poor quality. Today, all steps in manufacture are closely controlled. Bloating properties of the raw materials are determined well in advance of mining. The kiln feed is carefully sized and the firing temperature is kept under constant surveillance. In addition, the size gradation of the product is adjusted to meet both American Society for Testing Materials (A.S.T.M.) specifications and those of the consumer.

The use of controls over each stage in the process makes it possible for the manufacturer of lightweight aggregate to deliver a uniform product having the following unique properties:

1. Lightweight—Depending on the aggregate and the strength required, concrete containing lightweight aggregate will weigh from 90 to 115

pcf (pounds per cubic foot) (1,440 to 1,840 kg/m³). In contrast, sand and gravel concrete weighs about 150 pcf (2,400 kg/m³).

2. **Strength**—In a properly designed mix, lightweight aggregate will produce concrete that develops 5,000 pounds per square inch (350 kg/cm²) compressive strength in 28 days.
3. **Toughness**—The modulus of elasticity of lightweight concrete is about one half that of heavy concrete; as a result, it is tougher and more shock resistant.
4. **Insulation**—In thermal insulating value, an 8-inch- (20-cm-) thick wall of lightweight block is equal to a heavy concrete wall 34 inches (86 cm) thick.
5. **Stability**—Well-fired lightweight aggregate is chemically inert; it will not cause iron staining, and it is not attacked by salt water.

Preliminary (Quick-Firing) Tests

Lightweight aggregate is produced by expanding clay or shale in a rotary kiln or by sintering on a moving hearth. Clays that bloat between 1800 and 2200°F (980 and 1200°C) are preferred for rotary-kiln processing. A long temperature range between initial bloating and melting is required; a range of 100°F (38°C) is generally considered essential for rotary-kiln processing. The shales should crush to irregular lumps without flaking. Fines generally cause ring formation in the kilns so they must be removed from the feed. As a result, the minus-4-mesh material should not exceed 20 percent. The expanded particles should have a strong cell structure and a vitreous outer shell. In the alternate, sintering, process, clay fines are mixed with a combustible material and pelletized for firing on the moving hearth. The clay should vitrify with slight expansion at a temperature of 2200°F (1200°C) or below.

Quick-firing tests are used to determine the bloating characteristics of clays and shales within the range of commercial rotary-kiln operating temperatures (see “Testing Procedures”). On the basis of quick-firing data, the material tested can be classified according to its potential for use in the manufacture of lightweight aggregate as follows:

Promising—A material characterized by good cell structure encased in an impervious shell; one that will produce a coarse aggregate weighing less than 55 pcf (880 kg/m³), at a temperature not over 2200°F (1200°C), and has a processing range of at least 100°F (38°C) between initial bloating and overbloating.

Marginal—A clay that will bloat to specifications, but is refractory; one that may be a mixture of bloating and nonbloating materials; one that appears to have a short bloating range, or has poor crushing characteristics.

Not suitable—Materials that are nonbloaters; those high in lime, and those having a poor cell structure.

The quick-firing tests give data useful in appraising clays or shales as raw materials for lightweight aggregate, but the final evaluation must be based on data obtained from tests designed to approximate commercial operating conditions. Material that shows a positive quick-firing test is a candidate for pilot-scale rotary-kiln tests.

Rotary-Kiln Tests

Bulk samples weighing from 200 to 400 pounds (90 to 180 kg) are crushed to pass a 3/4-inch (1.9-cm) sieve. Only minus-3/4-inch (minus-1.9-cm) plus-4-mesh material is used; the rest is rejected as crushing loss.

A gas-fired rotary kiln 20 feet (6 m) long, having an inside diameter of 18 inches (46 cm), is used for testing samples found to be promising for lightweight aggregate in the preliminary tests. The kiln has a discharge slope of 1/4 inch per foot (2 cm/m), and a retention period of approximately 15 minutes (Liles and Heystek, 1977).

The kiln is heated to the temperature indicated in preliminary tests as required to produce aggregate weighing 55 to 65 pcf (880 to 1040 kg/m³). The temperature is raised gradually until the loose-pour weight of the uncrushed bloated material is in the range of 40 to 45 pounds per cubic foot (640 to 720 kg/m³). This temperature is maintained until about 150 pounds (70 kg) of expanded material is produced, and then the temperature is raised until sticking commences; this temperature is the upper limit of the firing range.

One half of each expanded sample is crushed to pass a 3/4-inch (1.9-cm) sieve, and is then separated on stacked screens into the size fractions required for coarse aggregate. The other half of the sample is crushed to pass a 3/4-inch (1.9-cm) sieve, and is separated into the size fractions required for fine aggregate. Screen analyses and loose-pour weights of each fraction are reported.

The sized aggregate must be tested in lightweight concrete before final evaluation is made.

CEMENT

Portland cement is a clinkered mixture of an argillaceous material and a calcareous material. The argillaceous material is usually clay or shale. The calcareous material may be limestone, cement rock, or marine shells. The stone-to-clay ratio should be about 3 to 1.

The use of shale and clay materials in the manufacture of portland cement depends upon their chemistry, because, when blended with a limestone, the mix must meet certain chemical specifications.

SEMIQUANTITATIVE X-RAY MINERALOGY

GENERAL STATEMENT

Semiquantitative X-ray diffraction estimates of the mineralogy of all the samples was carried out in a continuation of the program begun by O'Neill and others (1965) and continued by Hoover and others (1971) and O'Neill and Barnes (1979).

Initially, the X-ray investigations were carried out for two purposes: (1) to attempt to correlate mineral content with preliminary use evaluations in the hope that X-ray diffraction might prove to be a viable tool in future exploration, and (2) to obtain basic information concerning the mineralogy of Pennsylvania shales and clays (O'Neill and others, 1965, p. 21). This dual purpose continued through the investigations of Hoover and others (1971) and O'Neill and Barnes (1979). Each of those previous studies has shown that some correlation can be made between mineralogical composition and certain potential uses. However, the mineralogical ranges included within most preliminary use categories overlap or are so broad that conclusions regarding potential use drawn from mineralogical composition are impossible. For this reason, no attempt to correlate these data is made in this study, and the X-ray diffraction data are presented only to add to the information available regarding the mineralogy of Pennsylvania shale and clay deposits.

As in the previous investigations, the large number of samples, together with time limitations, necessitated the implementation of X-ray diffraction procedures that involve a large number of compromises and assumptions. The procedure used is that used in the most recent of the previous clay-shale studies (O'Neill and Barnes, 1979, p. 21-30), and is discussed briefly below.

ANALYTICAL PROBLEMS

There are three categories of problems that can influence any attempt to quantify X-ray diffraction data: (1) the effect of the chemical composition of the sample on the absorption of primary X-rays and the emission of secondary X-rays, which can lower the peak-to-background ratio; (2) the degree of crystallinity, orientation, and size and shape of the mineral grains, which determines in part the efficiency of the sample as a diffracting medium; and (3) instrument stability.

The quantification of diffraction data from clay minerals is made particularly difficult because the chemical and physical properties of these minerals aggravate the problems associated with item 2 above in the following ways:

(1) The crystallinity of some clay minerals can vary widely, because of chemical substitutions or vacant sites in the crystal structure. A well-crystallized mineral produces a sharp, intense diffraction peak, whereas a poorly

crystallized one produces a broad peak of lower intensity. To help overcome this problem, intensity was measured as the area under the peak, rather than as peak height. This, theoretically, should yield a more accurate representation of the total intensity and, hence, concentration.

(2) Ideally, all grains in an X-ray diffraction mount should be of the same size and randomly oriented. In clay and shale specimens, both size and orientation are difficult to control. The samples contain minerals that have a wide range of hardness. When crushed, the harder minerals, such as quartz, resist breakup and persist as larger grains than the clay minerals. Because too much grinding destroys the structure of the clay minerals, broadening and eliminating their diffraction peaks, excessive grinding was avoided and larger quartz grains were tolerated. The treatment of all samples in the same manner, and treatment of the standards in a comparable way, is believed to have minimized problems related to this effect.

The clay minerals that make up most of each sample consist of tiny flakes that become lined up parallel to the surface of an X-ray sample holder when the sample is compressed. This causes increased diffraction intensity for the basal spacings of the oriented minerals and decreased intensity for other minerals that can be masked by these oriented flakes. This effect normally tends to cause overestimation of the area of flakes present in a sample relative to their true weight. To reduce this effect, sample holders that are loaded from the back were used. As before, however, the principal approach to reduce this problem was to treat all samples and standards in the same way. Because different samples of a given clay species have varying degrees of flakiness, this approach offers only a partial solution.

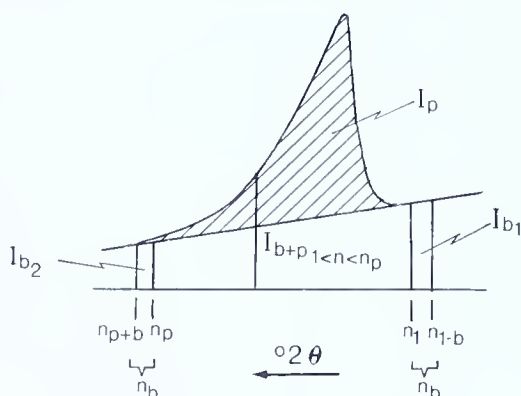
The other problems associated with the quantification of X-ray diffraction data are probably no more serious for clay minerals than for any others.

CALIBRATION

Sixteen standard mixtures were prepared using the eight mineral species or groups listed in Table 3. The samples used in preparing the mixtures were selected on the basis of purity and, when possible, the degree to which they might be representative of the mineral varieties encountered in the clay and shale samples. The mixtures used are the same ones prepared by O'Neill and Barnes (1979) and are shown in Table 4. Prior to O'Neill and Barnes' study, an X-ray diffractometer scan of each component was prepared to determine its purity and to locate characteristic diffraction peaks of reasonable intensity that have a minimum of interference problems with other commonly occurring minerals. The possibility of potential interference problems was further checked by examination of the diffraction data listed by Grim (1968) and by the JCPDS-International Centre for Diffraction Data. Characteristic peaks were selected for each mineral (Table 5). In addition, the in-

tensities of the 7Å and 14Å peaks were determined and compared to the intensities of the less sensitive characteristic peaks of chlorite, vermiculite, and kaolinite, as a check. Correlation coefficients of peak area versus concentration were calculated from the standard mixtures. These indicate good reliability for most peaks, ranging from 0.9947 for quartz to 0.7900 for the vermiculite 0·0·10 spacing. All but vermiculite are greater than 0.9. These correlation coefficients would, of course, be reduced in measurement of natural samples.

The integrated intensities were obtained by step-scanning across the peak, and the X-ray intensity was automatically measured at each step. Step-scanning of the selected peaks was controlled by a Philips 3181 Angle Mode Programmer. The counts were obtained with a Philips 3000 Series Data Measuring System interfaced to an Olivetti P602 microcomputer that calculated the integrated intensity using versions of Philips Electronic Instruments programs 6/QXD/OFL/3 and 6/QXD/ONL/4, modified to allow a larger number of peaks per sample using MLU600 tape storage of data. The formula by which the intensity was calculated can be expressed as follows:



$$I_p = \sum_{n_1}^{n_p} \left(I_{b+p_n} - \frac{\sum_{n_1-b}^{n_1} I_{b1_n} + \sum_{n_p}^{n_{p+b}} I_{b2_n}}{2n_b} \right)$$

where I_p = integrated intensity of peak

n_p = number of steps required to traverse peak

I_{b+p_n} = intensity of background + peak counted at each step n

n_b = number of steps counted as background on each side of peak

I_{b1_n} = intensity of background counted at each step n on low 2θ side of peak

I_{b2_n} = intensity of background counted at each step n on high 2θ side of peak

A counting time of 0.2 second/step and a step increment of $0.02^\circ 2\theta$ yielded the best combination of efficiency and accuracy. The 2θ range se-

Table 3. *Mineral Components of Standard Mixtures*

Mineral species or group	Location	Comments
Feldspar	Bancroft, Ontario	Albite
Calcite	Chihuahua, Mexico	"Island Spar"
Chlorite	Kline's quarry, York County, Pennsylvania	Chamosite (Barnes, 1978)
Mica	Fithian, Illinois	Illite, minor quartz*
Kaolinite	Bath, South Carolina	A.P.I. Kaolinite #7, minor quartz*
Smectite	Belle Fourche, South Dakota	A.P.I. Montmorillonite #27, 001 peak at 13.23Å
Quartz	Arkansas	Novauculite
Vermiculite	Brinton's quarry, Chester County, Pennsylvania	Minor muscovite

*Mica standard contains $4.2 \pm .5\%$ quartz, and kaolinite standard contains 3% quartz by method of standard addition.

lected for each peak is indicated in Table 5. In each case the first five steps ($0.1^\circ 2\theta$) and the last five steps were counted as background.

The 16 standard mixtures listed in Table 4 were run in succession three times. These results were used to plot calibration curves for each mineral. The contributions of kaolinite, chlorite, and vermiculite to the "7Å" and "14Å" peaks were determined, and separate calibration curves for each of these minerals using these peaks were calculated.

Interference between mica and smectite presented the most serious problem. Smectite has the ability to expand and collapse as its moisture content varies. Consequently, the 001 spacing of smectite can vary from about 9.9Å, which coincides with the 001 of mica, to 14Å, which coincides with the chlorite and vermiculite basal spacings. Most of the smectite encountered in this study is in a partially hydrated form having a spacing of 10 to 11Å, which is observed in careful scans as a broad, asymmetric "tail" on the low- 2θ side of the mica 001 peak. Tests of the expandability of this material in several samples, using ethylene glycol, were positive and confirmed its identification as a smectite or a smectite-bearing mixed-layer material (O'Neill and Barnes, 1979). The presence of this partially hydrated smectite influenced the intensity of the "10Å" mica peak in two ways: (1) completely dehydrated smectite was indistinguishable from mica and yielded an enhanced mica intensity; (2) partially hydrated smectite interfered with the low- 2θ background count for mica, yielding an artificially low mica intensity.

Because of the presence of some smectite in most samples, coupled with the variability in intensity and position of the smectite basal reflection, the mica calibration curve proved unusable. The use of other basal mica reflections was impossible because of interferences with other common minerals.

Table 4. *Standard Mixtures for Semiquantitative X-ray Diffraction Given in Weight Percent*

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Chlorite	20	19	0	10	3	0	3	8	2	14	0	0	0	4	2	0
Vermiculite	3	8	10	6	1	0	1	0	1	1	0	0	1	0	2	3
Smectite	13	15	9	0	20	17	3	8	1	1	3	0	2	1	4	6
Quartz*	38.4	27.2	19.9	33.5	60.4	64.8	70.8	50.6	8.5	8.0	11.6	16.8	1.7	9.1	16.7	2.6
Mica*	0	21.1	44.1	34.5	4.8	18.2	14.4	9.6	76.6	68.0	59.4	3.8	0	49.8	24.0	28.7
Feldspar	8	0	17	13	3	0	1	9	3	5	26	27	24	6	10	10
Kaolinite*	13.6	9.7	0	0	6.8	0	4.9	4.9	5.8	0	0	51.4	55.3	30.1	21.3	41.7
Calcite	4	0	0	3	1	0	2	10	2	3	0	1	16	0	20	8
Totals:	100.0	100.0	100.0	100.0	100.0	100.0	100.1	100.1	99.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0

*Values corrected for quartz impurity in mica and kaolinite.

Table 5. *X-ray Diffraction Peaks Selected for Semiquantitative Estimates*

No.	Mineral	hkl	d(Å)	°2θ Scanned (CuKα)
1	Quartz	100	4.26	20.40-21.30
2	Calcite	104	3.035	28.90-30.00
3	Mica	001	10	7.50- 9.60
4	Feldspar	002, +	3.19	27.30-28.60
5	Kaolinite	20 $\bar{2}$, 1 $\bar{3}$ 1, 11 $\bar{3}$	2.34	38.00-38.90
6	Kaolinite + chlorite	00 ℓ	7	11.00-13.20
7*	Vermiculite	1 · 1 · 10	2.87	30.90-31.30
8	Chlorite + vermiculite + smectite	00 ℓ	14	5.00- 7.70
9	Chlorite	005, 024	2.83	31.40-31.90

*Shifts of the basal dimensions of vermiculite could result in underrepresentation of this mineral in some samples.

Other mica hkl reflections either have interferences with other common minerals, or are extremely weak and vary with mica composition. Likewise, the use of the “14Å” peak as an indicator of smectite content is very dubious, since the low-2θ tail on the mica peak, indicative of partially hydrated smectite that would not be observed at 14Å without additional sample treatment, is present in most samples. This peak was used in estimating total chlorite, vermiculite, and smectite (montmorillonite) by O'Neill and others (1965) and Hoover and others (1971), and for estimating “hydrated montmorillonite” (hydrated smectite) by O'Neill and Barnes (1979, p. 26). Because of the extreme variability in the crystallinity and hydration of smectite, and the major contribution to 14Å intensity by chlorite and/or vermiculite, this practice is discontinued in this report.

Therefore, the only avenue remaining open for determining mica and smectite, consistent with “rapid, semiquantitative” methodology, is their determination by subtraction after all of the other mineral components have been determined. They are reported as “mica,” which is total mica plus smectite. This method was chosen because (1) the aforementioned problems prevent a quick and reliable direct determination of mica and smectite concentrations; (2) the calibration curves for the other minerals appear to be reasonably reliable; (3) complete X-ray scans of numerous samples revealed only minor amounts of minerals not included in this program. For each sample, the “10Å” intensity was compared with the reported mica plus smectite for approximate agreement. Whenever a major discrepancy was noted, the sample was subjected to a complete X-ray scan to check for additional, unanticipated components.

PROCEDURE

After sample preparation and the measurement of integrated intensities,

the following procedure was followed to determine the quantities of minerals in each sample:

1. Determine percent quartz from curve.
2. Determine percent calcite from curve.
3. Determine percent feldspar (estimated total) from curve.
4. Determine percent kaolinite from curve using $20\bar{2}$, $13\bar{1}$, $11\bar{3}$ peak at 2.34\AA .
5. Determine theoretical kaolinite contribution to " 7\AA " intensity.
6. Determine percent vermiculite from curve using $0\cdot0\cdot10$ peak at 2.87\AA .
7. Determine theoretical vermiculite contribution to " 7\AA " peak and " 14\AA " peak and subtract.
8. Determine percent chlorite from curve using 005 , 024 peak at 2.83\AA .
9. Determine theoretical chlorite contribution to " 7\AA " peak and " 14\AA " peak and subtract.
10. Make minor adjustments (± 5 percent or less) to the percentages of kaolinite, chlorite, and vermiculite to account for the observed " 7\AA " and " 14\AA " intensities, which are more sensitive indicators of concentration than the less intense peaks previously measured (steps 4, 6, and 8).
11. Examine the X-ray chart for all the regions scanned for interferences, appropriate peak heights, and exceptionally broad " 10\AA " or " 14\AA " peaks that could be caused by smectite.
12. Subtract the total of all minerals observed thus far from 100 percent, and designate the remainder "mica + smectite" (the 10\AA class).
13. Compare the "mica + smectite" percentage with the 10\AA "mica" calibration curve to ascertain that there is at least approximate agreement. If not, or if interferences were observed in step 11, subject the sample to a complete X-ray scan. Estimate the concentration of minerals encountered that are not a part of this program, e.g., gypsum and pyrite.

ACCURACY AND PRECISION

Absolute tests of accuracy were not possible because compatible standard shale samples for which the mineral concentrations are accurately known are not available. Tests were made, however, by O'Neill and Barnes (1979) to compare the results obtained by the method used in that report and this report with the method used previously in this series by O'Neill and others (1965) and Hoover and others (1971). Five samples studied by Hoover and others were tested by this method and the results compared (O'Neill and Barnes, 1979, Table 9). The comparison shows generally good agreement, most differences being in the minor constituents, which are most susceptible

to difficulties related to preferred orientation and inhomogeneity of the samples. Some differences would also be anticipated in view of the compromises and assumptions required by both methods.

A comparison was also made by O'Neill and Barnes (1979, Table 10) of the chemical analyses of the above samples reported by Hoover and others (1971) with the chemistry as calculated from the two X-ray mineralogical determinations (assuming stoichiometry and the chlorite: vermiculite: smectite (montmorillonite) ratio of 4:2:1 assumed by Hoover and others). The results show generally better agreement between the two calculations from the X-ray diffraction studies than between either of them and the chemical analyses. Because the chemical analyses are probably more accurate, this could as likely be caused by deviations from stoichiometry that are common in clay minerals as by similar errors in the two X-ray methods. In the sample data, discrepancies between mineralogy and major- and minor-oxide analyses will be noted. In these cases, preference should be given to the major- and minor-oxide analyses.

As a continuation of testing, and a check of the current procedure, five samples from southwestern Pennsylvania, originally reported by O'Neill and Barnes (1979), in Pennsylvania Geological Survey Mineral Resource Report 77 (hereafter referred to as M 77), were selected at random and re-run as a part of this study (Table 6). The results are similar, but there are some differences. Two of the samples (24-C-2A and 59-B-6) showed the presence of chlorite in M 77, and vermiculite in this study. This is a matter of interpretation when dealing with such small quantities of minerals as would normally only be detected by the "14A" and "7A" peaks, which they share with each other and with kaolinite. For this reason, it was decided to combine these two minerals in the data tables. Another interesting sample is 48-C-4. This study indicates "mica + smectite" as 52 percent. The values reported for M 77 are mica, 39 percent, and smectite (montmorillonite), 15 percent (total = 54 percent). The values for M 77 were arrived at by obtaining a complete scan after the results from the step-scanning indicated an unusual specimen. The presence of the smectite was further checked (for M 77) by the preparation of oriented aggregates and glycolation, which reveals the smectite by causing it to expand to a basal spacing of approximately 15A. Because, with the exception of the method of reporting smectite, the procedure is essentially the same for both studies, the other differences appear to be random and probably a function of sample inhomogeneity and preferred orientation.

The low precision indicated above is typical of the method. As a test of precision, at the start of their project, O'Neill and Barnes (1979) selected two samples and ran each of them 10 times in succession, repacking the powder in a sample holder each time. Those results are listed in Table 7. In addition to the problems cited above, the exceptionally large standard deviations for calcite, chlorite, vermiculite, smectite, and feldspar could be

Table 6. Comparison of X-Ray Diffraction Procedures, M 77* Versus This Study

Sample number	Quartz		Mica†		Kaolinite		Chlorite		Vermiculite		Montmorillonite‡		Feldspar		Calcite	
	M 77	This study	M 77	This study	M 77	This study	M 77	This study	M 77	This study	M 77	This study	M 77	This study	M 77	This study
6-C-14	31	28	50	50	14	19	0	0	0	3	4	—	0	0	1	0
24-C-2A	24	18	48	55	25	25	2	0	0	1	0	—	1	1	0	0
48-C-4	18	16	39	52	24	32	0	0	0	0	15	—	1	0	0	0
59-B-6	42	44	42	30	11	24	4	0	0	1	0	—	1	1	0	0
69-A-3	25	26	56	59	12	4	6	8	0	2	0	—	1	1	0	0

*“M 77” refers to O’Neill and Barnes (1979)

†“Mica” indicates mica plus partially hydrated (10A) smectite in M 77, and mica plus all smectite in this study.

‡“Montmorillonite” indicates hydrated smectite (basal spacing 14A) in M 77. This category was not included in this study.

Table 7. Ten Successive Replicate X-Ray Determinations of Two Samples Given as an Indication of Precision

Sample 46-C-2A

Sample 4-C-3B

	Mean	Std. dev.	8/18/76*	Mean	Std. dev.	12/3/76*
Quartz	19.2 ⁰⁰	2.04	17 ⁰⁰	41.5 ⁰⁰	3.98	35 ⁰⁰
Calcite	0.0	—	0	0.3	0.46	0
Mica	48.5	4.06	45	28.3	5.39	37
Feldspar	3.6	1.80	2	0.6	0.92	3
Kaolinite	26.2	4.21	32	27.9	4.93	25
Vermiculite	0.7	1.42	0	0.5	1.20	0
Chlorite	1.4	1.36	0	0.4	0.92	0
Smectite	0.4	0.66	4	0.5	1.20	0

*Results of a single determination of the sample in its normal sequence during the course of the project.

a function of a low signal-to-noise ratio in the measurement of peaks of very low intensity.

The mineralogical data presented in this report are intended as an estimate of the mineral content of the samples. Reported differences between samples of less than 5 percent of the major constituents (quartz, mica + smectite, kaolinite) or less than 2 percent of the other constituents are probably not significant. Fortunately, such differences are probably not significant in the evaluation of the use potential of a raw material, inasmuch as most uses appear to tolerate a rather broad mineralogical range (O'Neill and Barnes, 1979, Figures 6-9).

CHEMICAL ANALYSES

GENERAL STATEMENT

As in the previous phases of this project (O'Neill and others, 1965; Hoover and others, 1971; O'Neill and Barnes, 1979), quantitative chemical analyses were performed to determine major and minor elements in each sample. As with the X-ray diffraction, the initial attempts were made in order to test the possibility of using these data as a means of evaluating the usefulness of a raw material for various applications, and to add to the overall data available for Pennsylvania clays and shales.

Tests of correlation between use and chemical composition by the previous investigators have yielded little in the way of useful criteria. Although some potential uses can be correlated with certain concentration ranges for one or more elements, most uses have overlapping ranges or broad ranges of composition. The analyses were continued in this phase of the project

only to add to the data available on the clay and shale resources of the Commonwealth.

The analyses were performed by atomic absorption and flame emission using the Perkin-Elmer Model 305A atomic absorption apparatus. The elements determined by atomic absorption, expressed as oxides, are SiO_2 , TiO_2 , Al_2O_3 , total Fe as Fe_2O_3 , MnO , MgO , and CaO . Na_2O and K_2O were analyzed by flame emission.

PROCEDURES

The method of sample preparation was the same as that used by O'Neill and Barnes (1979), and was based on that described by Medlin and others (1969), with some minor modifications suggested by N. H. Suhr (personal communication, 1976). All glassware and plasticware were cleaned in a chromic acid cleaning solution. Splits of the powdered sample were heated to 115°C for one hour and stored in a desiccator. A 0.2000-g aliquot of each minus-200-mesh sample was thoroughly mixed with 0.8000 g of dried LiBO_2 using an agate mortar and pestle for approximately 10 to 12 minutes. After mixing, the material was transferred to a pre-ignited graphite crucible. It was then fused in a muffle furnace at 1000°C for 12 minutes, then transferred, while still molten, into 40 mL of 4 percent HNO_3 in a polypropylene beaker. This stock solution was stirred gently in a covered beaker using a magnetic stirrer for one-half hour, after which it was transferred to a Nalge polypropylene 125-mL bottle.

Two dilutions were made from the stock solution. One was prepared by mixing 4 mL of stock solution with 40 mL of the La solution "A" described by Medlin and others (1969). This La dilution was used in the determination of all the elements but Na_2O and K_2O . The dilution for these two elements was prepared by mixing 1 mL of stock solution with 60 mL of distilled and deionized water.

A list of the materials used as standards for each element is presented in Table 8. All of these reference samples have been repeatedly analyzed by many laboratories, and their compositions are well documented. The values assigned for these analyses are, in most cases, the average of the values reported by Flanagan (1970) and Abbey (1972). The "blank" that was used in the analysis of some elements was prepared in the same manner as the other samples except for the omission of the sample material.

Two synthetic "shale" standards, "Pennsylvania Average Shale" and "Earth Average Shale," were prepared from reagent-grade chemicals. The values selected for the "Pennsylvania Average Shale" are based on the results reported by O'Neill and others (1965) in their statewide survey of clay and shale deposits. Those for the "Earth Average Shale" are based on values given by Turekian and Wedepohl (1961). The reagents used were SiO_2 (optical-quality Brazil quartz), Al_2O_3 , Fe_2O_3 , MgO , CaCO_3 , Na_2CO_3 ,

Table 8. Assumed Values, in Percent, of Materials Used as Standards for Chemical Analyses

Material	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	MgO	CaO	Na ₂ O	K ₂ O	TiO ₂	MnO
Blank				0.00	0.00	0.00	0.00	0.00	0.000
AGV-1		17.24		1.54	4.95	4.28			0.096
BCR-1		13.64	13.46	3.47	6.95	3.28	1.69	2.21	0.180
Earth Avg.				2.49	3.09	1.29		0.77	
G-2	69.15	15.38	2.66	0.76	1.96		4.51	0.50	0.034
GSP-1	67.35		4.33			2.80	5.53		
Mica-Fe									0.350
Mica-Mg								1.67	0.242
PCC-1	42.03	0.74	8.32	1.11	0.85	0.67	3.29	1.00	0.116
Pa. Avg.		18.91	6.29						
Shp-1	60.46		6.97						
W-1	52.68		11.10	6.62	10.97	2.15	0.64	1.07	0.167
98a*	48.94	33.19		0.42	0.31	0.082	1.04		
56-316†	61.40	20.48					3.65		

*Analyzed plastic clay (shale from Clearfield County, Pa.), Office of Standard Reference Materials, National Bureau of Standards, Washington, D.C.

†Analyzed shale, Mineral Constitution Laboratory, Pennsylvania State University, University Park, Pa.

TiO₂, CaHPO₄, and MnO₂. The assumed concentrations, and those obtained by atomic absorption analysis, are presented in Table 9.

As a test of the method, prior to their study, O'Neill and Barnes (1979) performed complete or partial analyses on 22 international reference rock samples. The results obtained were compared with those commonly accepted (see Flanagan, 1970, and Abbey, 1972) and generally showed good agreement (O'Neill and Barnes, 1979, Table 15).

Table 9. *Composition of Synthetic "Shale" Standards*

Oxide	PENNSYLVANIA AVERAGE SHALE		EARTH AVERAGE SHALE	
	Intended conc.	Analyzed conc.	Intended conc.	Analyzed conc.
SiO ₂	60.40%	62.5 %	58.42%	62.2 %
Al ₂ O ₃	18.91	18.60	15.11	15.72
Fe ₂ O ₃	6.29	6.51	6.75	7.16
MgO	1.11	1.13	2.49	2.47
CaO	0.85	0.83	3.09	3.18
Na ₂ O	0.67	0.72	1.29	1.37
K ₂ O	3.29	3.31	3.20	3.21
TiO ₂	1.00	1.02	0.77	0.78
P ₂ O ₅	0.15	—	0.16	—
MnO	0.20	0.169	0.110	0.120

The samples were prepared in batches of 21. Half of the standards were freshly fused with each group of samples, and fresh dilutions of all the standards were prepared each time a new group of samples was to be run. Samples were analyzed on the day following fusion and dilution. The samples were run in groups of seven, alternating between aspiration of samples and standards. All runs were repeated in reverse order to compensate for drift, and the readings obtained from two runs were averaged for calculations of concentration. The calculation was carried out by hand-plotting absorbance versus concentration of the standards to obtain a new calibration curve for each group of seven samples. Most calibration curves were nearly linear. In cases where the curve was nonlinear, a best fit was estimated and the curve was drawn using a standard irregular drafting curve as a guide. When a "blank" standard was used, the absorbance obtained when it was aspirated was taken as the zero point. For other elements, the origin was taken as the zero point.

The precision for the analyses, taken as one standard deviation of the scatter of the standard data points, is typically as follows: SiO₂, ± 0.6 percent; Al₂O₃, ± 0.15 percent; Fe₂O₃, ± 0.06 percent; MgO, ± 0.03 percent; CaO, ± 0.04 percent; Na₂O, ± 0.03 percent; K₂O, ± 0.07 percent; TiO₂, ± 0.01 percent; MnO, ± 0.002 percent.

SAMPLE DATA AND TEST RESULTS

The following pages contain descriptive data and test results for each of the 143 samples collected in the 10-county project area. The order of presentation is by county and, within each county, by sample number. For each sample, the following are supplied: township, quadrangle, location including latitude and longitude, stratigraphic position and field description, major- and minor-oxide analysis, semiquantitative estimate of mineralogic composition, and the results of physical testing, including slow-firing tests. For samples showing a positive test for bloating, the results of rotary kiln tests are also provided.

In using the following tables, please note the following:

- (1) Geologic unit: Based primarily on the map of Gray and others (1960).
- (2) Chemical analysis: Iron expressed as Fe_2O_3 represents the sum of FeO plus Fe_2O_3 . Elements not reported were not analyzed.
- (3) Mineralogy: Numbers represent semiquantitative estimates only. "Mica" represents the mica group of minerals, including illite, plus the smectite group and mixed-layer materials containing these groups. The presence of minerals in addition to those listed is not precluded.
- (4) Physical testing: The following abbreviations are used:
 - Absorp.: absorption
 - App. por.: apparent porosity
 - N. D.: not determined
 - Shk.: shrinkage
- (5) Potential uses: Because the data presented are based on laboratory tests of limited samples, and because these tests are preliminary in nature and will not suffice for plant or process design, the potential uses should be interpreted only as *preliminary* evaluations of the use that a material might have. Additional uses of a material in a mixture with other materials are not precluded. In each case, *the potential developer of a prospect must make the final judgment of the suitability of a given raw material for his particular process*. Such judgments will normally follow careful evaluation of the physical properties herein reported, further field studies to determine the extent and ease of extraction of the deposit, and full-scale plant testing of the raw material.

BEDFORD COUNTY

BEDFORD TOWNSHIP

RAINSBURG QUADRANGLE

SAMPLE NUMBER 79-B-13A

LOCATION: Shale pit on the northeast side of a light-duty road leading southeast from U. S. Route 220. The pit is located about 0.45 mile (700 m) east-northeast of the north-eastern corner of the cemetery at Burning Bush.

LATITUDE: 39°56'17"N

LONGITUDE: 78°34'28"W

GEOLOGIC UNIT: Mahantango Formation, Devonian

DESCRIPTION: Grayish-orange (10YR7/4), light-brown (5YR6/4), and dark-yellowish-orange (10YR6/6), thin- to thick-bedded shaly siltstone. Beds range in thickness from 2 to 24 inches (5 to 61 cm). Shaly siltstone forms chippy, hackly fragments when broken with hammer, but many fragments at toe of quarry walls are slabby, having long dimensions that measure more than 2 feet (61 cm). Iron staining in slight to moderate amounts coats fracture surfaces and bedding planes. Joint system is well developed; spacing between joints ranges from 2 to 10 inches (5 to 25 cm).

ATTITUDE OF BEDDING: N42E, 24SE

WEATHERING INTENSITY: Moderate

SAMPLED INTERVAL: Channel sample through 10 feet (3 m) of stratigraphic section

CHEMICAL ANALYSIS:

MINERALOGY (X-RAY):

	%		Weight %
SiO ₂	>72	Quartz	52
Al ₂ O ₃	8.20	Mica-smectite	46
Σ"Fe ₂ O ₃ ".....	3.89	Kaolinite	0
MgO.....	0.85	Chlorite-vermiculite	0
CaO.....	0.15	Feldspar	0
Na ₂ O.....	0.11	Calcite	0
K ₂ O.....	1.98		
TiO ₂	0.40		
MnO.....	0.069		
Total	>87.65		

RAW PROPERTIES:

Water of plasticity (%): 20.4
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Fair
 pH: 5.0

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800	Mod. yellowish pink to					
1000	mod. orange (5YR7/6)	3	2.5	17.9	31.6	1.76
1900	Mod. yellowish pink to					
1050	mod. orange (5YR7/6)	3	2.5	17.6	31.1	1.77
2000						
1100	Mod. orange (2.5YR6/8)	3	2.5	15.2	27.4	1.81
2100						
1150	Brownish orange (2.5YR5/8)	4	2.5	13.6	25.0	1.84
2200						
1200	Strong brown (2.5YR4/6)	4	5.0	10.7	20.2	1.87
2300	Mod. reddish brown					
1250	(10R4/4)	4	5.0	9.8	18.2	1.89

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Building brick at 1150-1250°C.

BEDFORD COUNTY

BEDFORD TOWNSHIP

RAINSBURG QUADRANGLE

SAMPLE NUMBER 79-B-13B

LOCATION: Shale pit on the northeast side of a light-duty road leading southeast from U. S. Route 220. The pit is located about 0.45 mile (700 m) east-northeast of the north-eastern corner of the cemetery at Burning Bush.

LATITUOE: 39°56'17"N

LONGITUOE: 78°34'28"W

GEOLOGIC UNIT: Mahantango Formation, Devonian

DESCRIPTION: Light-grayish-olive to light-olive-gray (5Y5/2 to 5Y6/1) shaly siltstone occurs directly beneath the shaly siltstone collected as sample 79-B-13A. The shaly siltstone breaks to form predominantly chippy to slabby fragments. Iron staining is slight to moderate along fracture surfaces and bedding planes. Joint system is well developed, consisting of three major sets. The joints are spaced from 2 to 10 inches (5 to 25 cm) apart.

ATTITUOE OF BEODING: N42E, 24SE

WEATHERING INTENSITY: Moderate

SAMPLED INTERVAL: Channel sample through 7.2 feet (2.4 m) of stratigraphic section

CHEMICAL ANALYSIS:		MINERALOGY (X-RAY):	
	%		Weight %
SiO ₂	>75	Quartz	42
Al ₂ O ₃	9.20	Mica-smectite	54
Σ"Fe ₂ O ₃ ".....	4.47	Kaolinite	0
MgO.....	1.13	Chlorite-vermiculite	3
CaO.....	0.14	Feldspar	1
Na ₂ O.....	0.11	Calcite	0
K ₂ O.....	2.62	RAW PROPERTIES:	
TiO ₂	0.46		
MnO.....	0.036		
Total	>93.17		
		Water of plasticity (%): 20.9	
		Drying shrinkage (%): 2.5	
		Workability: Short	
		Dry strength: Fair	
		pH: 5.5	

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800	Mod. yellowish pink to					
1000	mod. orange (5YR7/6)	3	2.5	18.8	32.7	1.74
1900	Mod. yellowish pink to					
1050	mod. orange (5YR7/6)	3	2.5	18.1	31.8	1.76
2000						
1100	Mod. orange (2.5YR6/8)	3	5.0	15.4	27.8	1.81
2100						
1150	Strong brown (2.5YR4/8)	4	5.0	12.4	23.2	1.87
2200						
1200	Strong brown (2.5YR4/6)	5	7.5	5.9	11.5	1.94
2300						
1250	---	---	Melted	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Short firing range. Abrupt vitrification between 1150 and 1200°C.

POTENTIAL USES: Marginal for structural clay products (building brick at 1150°C).

BEDFORD COUNTY

HARRISON TOWNSHIP

RAINSBURG QUADRANGLE

SAMPLE NUMBER 79-B-15

LOCATION: Road exposure along the southeast side of Pa. Route 96, about 2.3 miles (3.7 km) south-southeast of the village of Manns Choice.

LATITUDE: 39°58'36"N

LONGITUDE: 78°37'15"W

GEOLOGIC UNIT: Mahantango Formation, Devonian

DESCRIPTION: Medium-gray (N5) to moderate-olive-brown (5Y4/4), very thin to medium-bedded silty shale and shaly siltstone are exposed at this location. Thickness of beds ranges from less than 1 inch (3 cm) up to about 5 inches (13 cm), the thicker beds being siltstone. The shale breaks into platy fragments, the siltstone into slabby fragments. A moderate amount of iron staining occurs along joints and bedding.

ATTITUDE OF BEDDING: N34E, 56SE

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Channel sample through 10 stratigraphic feet (3 m)

CHEMICAL ANALYSIS:

MINERALOGY (X-RAY):

	%
SiO ₂	>70
Al ₂ O ₃	14.25
Σ"Fe ₂ O ₃ ".....	5.68
MgO.....	1.30
CaO.....	0.41
Na ₂ O.....	0.96
K ₂ O.....	2.60
TiO ₂	1.06
MnO.....	0.049
Total	>96.31

	Weight %
Quartz	43
Mica-smectite	37
Kaolinite	11
Chlorite-vermiculite	4
Feldspar	5
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 17.1
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Fair
 pH: 5.7

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800 1000	Mod. yellowish pink to mod. orange (5YR7/6)	2	2.5	18.0	32.2	1.79
1900 1050	Mod. to strong orange (2.5YR6/10)	3	2.5	16.8	30.5	1.82
2000 1100	Brownish orange (2.5YR5/8)	4	5.0	12.5	24.2	1.93
2100 1150	Strong brown (2.5YR4/6)	4	5.0	9.0	18.3	2.04
2200 1200	Mod. reddish brown (2.5YR3/4)	6	7.5	4.4	9.3	2.10
2300 1250	---	---	Melted	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Structural clay products (e.g., building brick at 1100-1200°C).

BEDFORD COUNTY

LONDONDERRY TOWNSHIP

HYNDMAN QUADRANGLE

SAMPLE NUMBER 79-C-14

LOCATION: Shale pit located on State Game Lands No. 48; pit is about 1.9 miles (3 km) east-northeast of the village of Fossilville.

LATITUDE: 39°52'27"N

LONGITUDE: 78°39'40"W

GEOLOGIC UNIT: Reedsville Formation, Ordovician

DESCRIPTION: Medium-dark-gray (N4) to olive-gray (5Y4/1), thin-bedded shale is exposed in this 8-foot- (2.5-m-) high pit. The shale breaks down to form platy, flaggy, and slabby fragments.

ATTITUDE OF BEDDING: N50E, 18SE

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Grab sample from fragments along floor of pit

CHEMICAL ANALYSIS:		MINERALOGY (X-RAY):	
	%		Weight %
SiO ₂	63.3	Quartz	23
Al ₂ O ₃	15.40	Mica-smectite	68
Σ"Fe ₂ O ₃ ".....	7.03	Kaolinite	0
MgO.....	2.25	Chlorite-vermiculite	2
CaO.....	0.35	Feldspar	7
Na ₂ O.....	1.27	Calcite	0
K ₂ O.....	3.18	RAW PROPERTIES:	
TiO ₂	0.92		Water of plasticity (%): 15.9
MnO.....	0.093		Drying shrinkage (%): 2.5
			Workability: Short
Total	93.79		Dry strength: Poor
			pH: 5.9

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800	Mod. yellowish pink to mod. orange (5YR7/6)	3	2.5	13.9	27.3	1.96
1000						
1900	Grayish reddish orange (2.5YR5/6)	3	2.5	11.4	23.4	2.04
1050						
2000	Strong brown (2.5YR4/6)	4	7.5	4.3	9.9	2.33
1100						
2100	Mod. reddish brown (2.5YR3/4)	6	7.5	1.4	3.3	2.18
1150						
2200	---	---	Melted	---	---	---
1200						
2300	---	---	---	---	---	---
1250						

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Short firing range. Abrupt vitrification between 1050 and 1100°C.

POTENTIAL USES: Marginal for structural clay products (building brick at 1100°C).

BEDFORD COUNTY SOUTH WOODBURY TOWNSHIP NEW ENTERPRISE QUADRANGLE

SAMPLE NUMBER 88-A-7A

LOCATION: Shale pit located west of Pa. Route 867, about 0.40 mile (640 m) north-northeast of the village of Brumbaugh.

LATITUDE: 40°11'04"N

LONGITUDE: 78°28'10"W

GEOLOGIC UNIT: Reedsville Formation, Ordovician

DESCRIPTION: Light-olive-gray (5Y5/2), very thin to thin-bedded shale is exposed in the western part of the north wall in this pit. Beds range from 0.7 to 3 inches (2 to 8 cm) in thickness. Joints are spaced from 1 to 6 inches (2.5 to 15 cm) apart. The shale breaks commonly to form chippy to slabby fragments, rarely splintery fragments. Some iron and manganese staining occurs along fracture and bedding planes.

ATTITUDE OF BEDDING: N16E, 78SE

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Channel sample through 10 feet (3 m) of shale

CHEMICAL ANALYSIS:

	%
SiO ₂	61.3
Al ₂ O ₃	16.50
Σ"Fe ₂ O ₃ ".....	7.72
MgO.....	2.04
CaO.....	0.38
Na ₂ O.....	0.66
K ₂ O.....	3.87
TiO ₂	0.98
MnO.....	0.095
Total	93.54

MINERALOGY (X-RAY):

	Weight %
Quartz	25
Mica-smectite	66
Kaolinite	0
Chlorite-vermiculite	5
Feldspar	4
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 19.6
 Drying shrinkage (%): 5.0
 Workability: Plastic
 Dry strength: Good
 pH: 6.0

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800	Mod. yellowish pink to					
1000	mod. orange (5YR7/6)	3	5.0	14.6	28.0	1.92
1900	Grayish reddish orange					
1050	(2.5YR5/6)	4	5.0	10.5	21.7	2.07
2000						
1100	Strong brown (2.5YR4/6)	5	10.0	3.8	8.9	2.32
2100	Mod. reddish brown					
1150	(2.5YR3/4)	5	10.0	1.5	3.5	2.35
2200						
1200	---	---	Melted	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Short firing range. Abrupt vitrification between 1050 and 1100°C.

POTENTIAL USES: Marginal for structural clay products (building brick at 1050°C).

BEDFORD COUNTY SOUTH WOODBURY TOWNSHIP NEW ENTERPRISE QUADRANGLE

SAMPLE NUMBER 88-A-7B

LOCATION: Shale pit located west of Pa. Route 867, about 0.40 mile (640 m) north-northeast of the village of Brumbaugh.

LATITUDE: 40°11'04"N

LONGITUDE: 78°28'10"W

GEOLOGIC UNIT: Reedsville Formation, Ordovician

DESCRIPTION: Light-olive-brown (5Y5/6), very thin to thin-bedded shale occurs stratigraphically above the shale collected in sample 88-A-7A. The beds range from 0.7 to 3 inches (2 to 8 cm) in thickness. Joints are spaced from 1 to 6 inches (2.5 to 15 cm) apart. The shale breaks commonly to form chippy to slabby fragments, rarely splintery fragments. Some iron and manganese staining is present along fracture and bedding planes.

ATTITUDE OF BEDDING: N16E, 78SE

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Channel sample through 10 feet (3 m)

CHEMICAL ANALYSIS:

	%
SiO ₂	61.7
Al ₂ O ₃	12.20
Σ"Fe ₂ O ₃ ".....	8.10
MgO.....	2.09
CaO.....	0.41
Na ₂ O.....	0.67
K ₂ O.....	3.92
TiO ₂	0.98
MnO.....	0.093
Total	90.16

MINERALOGY (X-RAY):

	Weight %
Quartz	26
Mica-smectite	61
Kaolinite	0
Chlorite-vermiculite	10
Feldspar	3
Calcite	0

RAW PROPERTIES:

Water of plasticity (%):	19.6
Drying shrinkage (%):	5.0
Workability:	Plastic
Dry strength:	Good
pH:	6.0

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800	Mod. yellowish pink to					
1000	mod. orange (5YR7/6)	3	5.0	12.3	24.6	2.01
1900	Grayish reddish orange					
1050	(2.5YR5/6)	4	5.0	9.0	19.2	2.13
2000						
1100	Strong brown (2.5YR4/6)	5	10.0	2.6	6.3	2.38
2100	Mod. reddish brown					
1150	(2.5YR3/4)	6	10.0	0.8	1.8	2.39
2200						
1200	---	---	Melted	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: ND

BLOATING TEST: Negative

REMARKS: Short firing range. Abrupt vitrification between 1050 and 1100°C.

POTENTIAL USES: Marginal for structural clay products (building brick at 1050°C).

BEDFORD COUNTY SOUTH WOODBURY TOWNSHIP NEW ENTERPRISE QUADRANGLE

SAMPLE NUMBER 88-A-8A

LOCATION: Shale pit located east of Pa. Route 867, about 1 mile (1.6 km) north-northeast of the village of Brumbaugh.

LATITUDE: 40°11'31"N

LONGITUDE: 78°27'51"W

GEOLOGIC UNIT: Reedsville Formation, Ordovician

DESCRIPTION: Olive-gray (5Y4/1) to dark-gray (N3), thin- to medium-bedded shale is exposed in the western part of the north and south walls of this pit. The thickness of the shale beds ranges from 1 to 5 inches (3 to 13 cm). The shale commonly breaks to form chippy to slabby fragments, rarely splintery fragments. Manganese staining is present along fracture and bedding planes.

ATTITUDE OF BEDDING: N13E, 83SE

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Channel sample through 20 feet (6 m) of shale

CHEMICAL ANALYSIS:		MINERALOGY (X-RAY):	
	%		Weight %
SiO ₂	60.5	Quartz	23
Al ₂ O ₃	16.70	Mica-smectite	66
Σ"Fe ₂ O ₃ ".....	7.90	Kaolinite	0
MgO.....	2.59	Chlorite-vermiculite	3
CaO.....	0.78	Feldspar	8
Na ₂ O.....	1.02	Calcite	0
K ₂ O.....	3.57		
TiO ₂	1.06		
MnO.....	0.104		
Total	94.22		

RAW PROPERTIES:
Water of plasticity (%): 18.0
Drying shrinkage (%): 5.0
Workability: Plastic
Dry strength: Good
pH: 6.3

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800	Mod. yellowish pink to					
1000	mod. orange (5YR7/6)	3	5.0	13.1	26.0	1.98
1900	Grayish reddish orange					
1050	(2.5YR5/6)	3	5.0	9.9	20.8	2.10
2000						
1100	Strong brown (2.5YR4/6)	4	7.5	3.7	8.7	2.33
2100	Mod. reddish brown					
1150	(2.5YR3/4)	5	10.0	1.1	2.5	2.36
2200						
1200	---	---	Melted	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Positive

REMARKS: ---

BLOATING TEST (QUICK-FIRING):

Temp. (°F) (°C)	Bulk density (g/cc) (lb/ft ³)		% Absorb.	Remarks
1800 1000	1.74	108.8	4.6	Slight expansion.
1900 1050	1.53	95.5	6.5	Slight expansion.
2000 1100	1.03	64.3	4.9	Good pore structure.
2100 1150	0.77	48.1	5.1	Good pore structure (sticky).
2200 1200	--	--	--	--
2300 1250	--	--	--	--

POTENTIAL USES: Lightweight aggregate (1100-1150°C).

BEDFORD COUNTY SOUTH WOODBURY TOWNSHIP NEW ENTERPRISE QUADRANGLE
SAMPLE NUMBER 88-A-8B

LOCATION: Shale pit located east of Pa. Route 867, about 1 mile (1.6 km) north-northeast of the village of Brumbaugh.

LATITUDE: 40°11'31"N LONGITUDE: 78°27'51"W

GEOLOGIC UNIT: Reedsville Formation, Ordovician

DESCRIPTION: Olive-gray (5Y4/1) to dark-gray (N3), thin- to medium-bedded shale is exposed in the western part of the north and south faces of this pit. Beds range in thickness from 1 to 5 inches (3 to 13 cm). The shale commonly breaks to form chippy to slabby fragments and some splintery fragments. Manganese staining is present along fracture and bedding planes. This sample is stratigraphically above sample BB-A-BA.

ATTITUDE OF BEDDING: N13E, 83SE

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Channel sample through 10 feet (3 m) of shale

CHEMICAL ANALYSIS:		MINERALOGY (X-RAY):	
	%		Weight %
SiO ₂	62.1	Quartz	22
Al ₂ O ₃	15.90	Mica-smectite	63
Σ"Fe ₂ O ₃ ".....	7.70	Kaolinite	5
MgO.....	2.56	Chlorite-vermiculite	3
CaO.....	0.44	Feldspar	7
Na ₂ O.....	1.23	Calcite	0
K ₂ O.....	3.47		
TiO ₂	1.02		
MnO.....	D.073		
Total	94.49		

RAW PROPERTIES:
Water of plasticity (%): 19.0
Drying shrinkage (%): 2.5
Workability: Plastic
Dry strength: Fair
pH: 6.5

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800 1000	Mod. yellowish pink to mod. orange (5YR7/6)	3	5.0	13.2	26.8	2.03
1900 1050	Grayish reddish orange (2.5YR5/6)	3	2.5	10.9	23.0	2.11
2000 1100	Strong brown (2.5YR4/6)	4	7.5	4.7	11.1	2.35
2100 1150	Mod. reddish brown (2.5YR3/4)	5	7.5	1.8	4.3	2.41
2200 1200	---	---	Melted	---	---	---
2300 1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: ND BLOATING TEST: Positive

REMARKS: ---

BLOATING TEST (QUICK-FIRING):

Temp. (°F) (°C)	Bulk density (g/cc) (lb/ft ³)		% Absorb.	Remarks
1800 1000	2.03	126.9	4.6	Slight expansion.
1900 1050	1.54	96.2	4.7	Slight expansion.
2000 1100	1.20	75.0	4.2	Good pore structure.
2100 1150	0.81	50.3	7.6	Good pore structure (sticky).
2200 1200	--	--	--	--
2300 1250	--	--	--	--

POTENTIAL USES: Lightweight aggregate (1100-1150°C).

BEDFORD COUNTY

BLOOMFIELD TOWNSHIP

NEW ENTERPRISE QUADRANGLE

SAMPLE NUMBER 88-A-9

LOCATION: Exposure along the south bank of a small stream about 0.95 mile (1.5 km) north-northeast of the village of Lafayetteville. The exposure is about 1,150 feet (350 m) west of Pa. Route 867.

LATITUDE: 40°13'03"N

LONGITUDE: 78°26'40"W

GEOLOGIC UNIT: Antes Member, Reedsville Formation, Ordovician

DESCRIPTION: Black fissile shale is exposed along the south bank of a small stream, from 2 to 24 inches (5 to 60 cm) above the level of water in the stream. This exposure is rated as fair.

ATTITUDE OF BEDDING: N18E, 34SE

WEATHERING INTENSITY: Moderate

SAMPLED INTERVAL: Channel sample through 14 feet (4 m) of shale

CHEMICAL ANALYSIS:

MINERALOGY (X-RAY):

ANALYSES NOT DONE BECAUSE SAMPLE HAS NO POTENTIAL USES

SiO₂.....

Quartz

Al₂O₃.....

Mica-smectite

Σ"Fe₂O₃".....

Kaolinite

Chlorite-vermiculite

MgO.....

Feldspar

Calcite

CaO.....

Na₂O.....K₂O.....TiO₂.....

MnO.....

Total

RAW PROPERTIES:

Water of plasticity (%): 19.2

Drying shrinkage (%): 2.5

Workability: Short

Dry strength: Fair

pH: 6.7

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800	Light reddish brown					
1000	(2.5YR6/4)	3	2.5	28.3	44.5	1.57
1900	Light reddish brown					
1050	(2.5YR6/4)	3	2.5	27.8	43.9	1.57
2000	Light reddish brown					
1100	(2.5YR6/4)	3	2.5	27.6	43.4	1.58
2100						
1150	---	---	Melted	---	---	---
2200						
1200	---	---	---	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Not suitable for use in structural clay products. Too soft.

BEDFORD COUNTY

BROAD TOP TOWNSHIP

HOPEWELL QUADRANGLE

SAMPLE NUMBER 88-B-10A

LOCATION: Strip mine operation owned by the New Enterprise Stone & Lime Co., Inc., located near the crest of Riddlesburg Mountain, about 1 mile (1.6 km) south-southeast of the village of Riddlesburg.

LATITUDE: 40°08'53"N

LONGITUDE: 78°15'06"W

GEOLOGIC UNIT: Freeport Formation, Allegheny Group, Pennsylvanian

DESCRIPTION: Medium-gray (N5) to olive-gray (5Y4/1) underclay to the upper seam of a split seam of the Upper Freeport (Kelly) coal was sampled on the west flank of a synclinal structure exposed in this strip mine. The underclay measured 6 feet (18 m) and lies directly below a coal which measures 34 inches (86 cm).

ATTITUDE OF BEDDING: N17E, 34SE

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Channel sample through 6 feet (1.8 m) of underclay

CHEMICAL ANALYSIS:

MINERALOGY (X-RAY):

	%		Weight %
SiO ₂	60.1	Quartz	31
Al ₂ O ₃	20.45	Mica-smectite	41
Σ"Fe ₂ O ₃ ".....	3.65	Kaolinite	25
MgO.....	1.13	Chlorite-vermiculite	2
CaO.....	0.20	Feldspar	1
Na ₂ O.....	0.20	Calcite	0
K ₂ O.....	3.20		
TiO ₂	1.02		
MnO.....	0.052		
Total	90.00		

RAW PROPERTIES:

Water of plasticity (%): 17.4
Drying shrinkage (%): 2.5
Workability: Short
Dry strength: Fair
pH: 5.6

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Brownish pink (5YR8/2)	3	2.5	20.8	36.5	1.76
1900						
1050	Brownish pink (5YR8/2)	3	2.5	19.7	35.2	1.79
2000	Mod. yellowish pink (5YR8/4)	3	5.0	15.1	29.2	1.94
1100						
2100						
1150	Light brown (5YR6/4)	3	7.5	9.7	20.7	2.13
2200						
1200	Light brown (5YR5/4)	4	10.0	5.6	12.6	2.26
2300	Light grayish reddish brown (2.5YR5/2)	5	10.0	2.0	4.7	2.39
1250						

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Structural clay products (e.g., floor brick at 1200-1250°C).

BEDFORD COUNTY

BROAD TOP TOWNSHIP

HOPEWELL QUADRANGLE

SAMPLE NUMBER 88-B-10B

LOCATION: Strip mine operation owned by the New Enterprise Stone & Lime Co., Inc., located near the crest of Riddlesburg Mountain, about 1 mile (1.6 km) south-southeast of the village of Riddlesburg.

LATITUDE: 40°08'53"N

LONGITUDE: 78°15'06"W

GEOLOGIC UNIT: Freeport Formation, Allegheny Group, Pennsylvanian

DESCRIPTION: Medium-dark-gray underclay to the lower split of the Upper Freeport (Kelly) coal was sampled on the west flank of a synclinal structure exposed in the strip mine. The underclay measured 5 feet (1.5 m) and lies directly below a coal which measures 52 inches (132 cm).

ATTITUDE OF BEDDING: N17E, 34SE

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Channel sample through 5 feet (1.5 m) of underclay

CHEMICAL ANALYSIS:

	%
SiO ₂	63.1
Al ₂ O ₃	19.45
Σ"Fe ₂ O ₃ ".....	3.70
MgO.....	0.84
CaO.....	0.08
Na ₂ O.....	0.19
K ₂ O.....	3.70
TiO ₂	1.07
MnO.....	0.020
Total	92.15

MINERALOGY (X-RAY):

	Weight %
Quartz	28
Mica-smectite	50
Kaolinite	18
Chlorite-vermiculite	3
Feldspar	1
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 18.7
 Drying shrinkage (%): 2.5
 Workability: Plastic
 Dry strength: Fair
 pH: 4.0

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800	Mod. yellowish pink					
1000	(5YR7/4)	3	2.5	18.2	33.1	1.82
1900	Mod. yellowish pink					
1050	(5YR7/4)	3	5.0	16.7	31.4	1.88
2000	Light yellowish pink					
1100	(5YR8/4)	3	5.0	10.6	22.4	2.11
2100						
1150	Light brown (5YR6/4)	4	7.5	5.0	11.5	2.31
2200						
1200	Light brown (5YR5/4)	5	7.5	1.2	2.8	2.45
2300						
1250	---	---	Melted	---	----	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Structural clay products (e.g., floor brick at 1150-1200°C).

BEDFORD COUNTY

HOPEWELL TOWNSHIP

HOPEWELL QUADRANGLE

SAMPLE NUMBER 88-B-11

LOCATION: Exposure along the north side of Pa. Route 26, about 1 mile (1.6 km) west of Hopewell Cemetery.

LATITUDE: 40°08'44"N

LONGITUDE: 78°17'32"W

GEOLOGIC UNIT: Brallier Formation, Devonian marine units, Devonian

DESCRIPTION: Olive-gray (5Y4/1), interbedded shaly siltstone and siltstone are exposed at this location. Beds range in thickness from $>1/2$ to $1\frac{1}{2}$ inches (<1.3 to 3.8 cm). The shaly siltstone and siltstone break down to form chippy to platy fragments which are commonly less than 2 inches (5 cm) in their long dimension. Similar material continues for an additional 16 feet (5 m) to the west of the sampled section.

ATTITUDE OF BEDDING: N6E, 72SE

WEATHERING INTENSITY: Slight

SAMPLED INTERVAL: Channel sample through 18 feet (6 m) of shaly siltstone

CHEMICAL ANALYSIS:

	%
SiO ₂	63.2
Al ₂ O ₃	17.35
Σ"Fe ₂ O ₃ ".....	6.95
MgO.....	1.50
CaO.....	0.13
Na ₂ O.....	0.65
K ₂ O.....	3.40
TiO ₂	0.97
MnO.....	0.035
Total	94.18

MINERALOGY (X-RAY):

	Weight %
Quartz	30
Mica-smectite	61
Kaolinite	0
Chlorite-vermiculite	6
Feldspar	3
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 15.6
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Fair
 pH: 5.4

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (5YR7/8)	3	2.5	14.8	29.3	1.97
1900						
1050	Mod. orange (2.5YR6/8)	3	2.5	13.1	26.4	2.02
2000						
1100	Brownish orange (2.5YR5/8)	4	5.0	9.2	20.0	2.18
2100						
1150	Strong brown (2.5YR4/8)	4	7.5	8.3	18.3	2.21
2200						
1200	Strong brown (2.5YR4/6)	5	7.5	4.7	11.0	2.31
2300						
1250	Mod. reddish brown (10R4/4)	6	7.5	2.9	6.8	2.33

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Structural clay products (e.g., building brick at 1100-1250°C). Good firing range.

BLAIR COUNTY

SNYDER TOWNSHIP

TIPTON QUADRANGLE

SAMPLE NUMBER 86-B-4A

LOCATION: Exposure on the southwest side of the access road at the Grazierville junk yard, located about 500 feet (150 m) north of the place where the stream named Fry Hollow discharges into the Little Juniata River.

LATITUDE: 40°38'52"N

LONGITUDE: 78°16'14"W

GEOLOGIC UNIT: Marcellus Formation, Devonian

DESCRIPTION: Black (N1) shale of the Marcellus Formation occurs above a 3½-inch- (9-cm-) thick, fine-grained limestone bed of the Onondaga Formation. The lower 3 feet (0.9 m) of shale weathers to make a blocky appearance and is overlain by a 2¼-inch- (6-cm-) thick Tioga bentonite bed containing mica. Above the bentonite, the beds of the Marcellus are more fissile.

ATTITUDE OF BEDDING: ---

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Channel through 28 feet (9 m) of shale

CHEMICAL ANALYSIS:

MINERALOGY (X-RAY):

	%
SiO ₂	60.7
Al ₂ O ₃	14.05
Σ"Fe ₂ O ₃ ".....	5.88
MgO.....	0.92
CaO.....	1.82
Na ₂ O.....	0.16
K ₂ O.....	3.39
TiO ₂	0.62
MnO.....	0.012
Total	87.55

	Weight %
Quartz	25
Mica-smectite	70
Kaolinite	0
Chlorite-vermiculite	3
Feldspar	1
Calcite	1

RAW PROPERTIES:

Water of plasticity (%): 18.5
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Fair
 pH: 7.5

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800	Grayish reddish orange					
1000	(2.5YR6/6)	3	2.5	19.8	34.4	1.73
1900	Grayish reddish orange					
1050	(2.5YR5/6)	3	5.0	17.1	30.9	1.81
2000						
1100	Strong brown (2.5YR4/6)	4	7.5	10.2	20.3	2.00
2100	Mod. reddish brown					
1150	(2.5YR3/4)	5	10.0	4.5	9.5	2.14
2200						
1200	---	---	Melted	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: ND

BLOATING TEST: Negative

REMARKS: Presence of carbonates could cause problems.

POTENTIAL USES: Structural clay products (e.g., building brick at 1100-1150°C).

BLAIR COUNTY

SNYDER TOWNSHIP

TIPTON QUADRANGLE

SAMPLE NUMBER 86-B-4B

LOCATION: Exposure on the southwest side of the access road at the Grazierville junk yard, located about 500 feet (150 m) north of the place where the stream named Fry Hollow discharges into the Little Juniata River.

LATITUDE: 40°38'52"N

LONGITUDE: 78°16'14"W

GEOLOGIC UNIT: Marcellus and Onondaga Formations, Devonian

DESCRIPTION: Sample includes the lower 3 feet (0.9 m) of black Marcellus shale, a 2½-inch (6-cm-) thick bentonite bed which occurs above the Marcellus interval, and the upper 10 feet (3 m) of the Onondaga Formation, which consists of limestone, calcareous shale, and two bentonite beds. The latter are 1½ inch (3.8 cm) and 1½ inch (3.2 cm) thick. The sampled interval includes four bentonite beds which total more than 7 inches (18 cm) of ash.

ATTITUDE OF BEDDING: ---

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Channel through 13 feet (4 m) of stratigraphic section

CHEMICAL ANALYSIS:

MINERALOGY (X-RAY):

ANALYSES NOT DONE BECAUSE SAMPLE HAS NO POTENTIAL USES

SiO₂.....
 Al₂O₃.....
 Σ"Fe₂O₃".....
 MgO.....
 CaO.....
 Na₂O.....
 K₂O.....
 TiO₂.....
 MnO.....

Quartz
 Mica-smectite
 Kaolinite
 Chlorite-vermiculite
 Feldspar
 Calcite

Total

RAW PROPERTIES:

Water of plasticity (%): 18.9
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Fair
 pH: 7.7

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800 1000	---	---	Decrep- itated	---	---	---
1900 1050	---	---	---	---	---	---
2000 1100	---	---	---	---	---	---
2100 1150	Yellowish white (5Y9/2)	4	2.5	33.0	46.8	1.42
2200 1200	Light reddish brown (2.5YR5/4)	5	5.0	16.5	26.8	1.62
2300 1250	---	---	Melted	---	---	---

PYROMETRIC CONE EQUIVALENT: ---

BLOATING TEST: ---

REMARKS: Presence of deleterious salts. High effervescence when treated with HCl.

POTENTIAL USES: Not suitable for use in structural clay products.

BLAIR COUNTY

ANTIS TOWNSHIP

TIPTON QUADRANGLE

SAMPLE NUMBER 86-B-5

LOCATION: Exposure on ridge along Tipton Run near Oysart Cemetery about 0.25 mile (400 m) south of the church in Tipton.

LATITUDE: 40°38'02"N

LONGITUDE: 78°17'54"W

GEOLOGIC UNIT: Marcellus Formation, Devonian

DESCRIPTION: Black (N1) fissile shales of the Marcellus Formation are exposed for a limited distance at this locality. The exact position of these shales within the Marcellus Formation is unknown.

ATTITUDE OF EXPOSING: ---

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Channel through 5.5 feet (1.7 m) of stratigraphic section

CHEMICAL ANALYSIS:

MINERALOGY (X-RAY):

	%
SiO ₂	56.4
Al ₂ O ₃	18.50
Σ"Fe ₂ O ₃ ".....	8.83
MgO.....	1.00
CaO.....	0.52
Na ₂ O.....	0.15
K ₂ O.....	4.27
TiO ₂	0.91
MnO.....	0.014
Total	90.59

	Weight %
Quartz	18
Mica-smectite	71
Kaolinite	6
Chlorite-vermiculite	3
Feldspar	1
Calcite	1

RAW PROPERTIES:

Water of plasticity (%): 21.4
 Drying shrinkage (%): 5.0
 Workability: Plastic
 Dry strength: Good
 pH: 7.6

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800 1000	Mod. orange (5YR6/8)	3	5.0	18.5	33.7	1.82
1900 1050	Brownish orange (5YR5/6)	3	5.0	12.9	25.6	1.99
2000 1100	Grayish reddish orange (2.5YR5/6)	4	10.0	4.8	11.0	2.32
2100 1150	Strong brown (2.5YR4/6)	5	12.5	0.8	2.0	2.44
2200 1200	Grayish reddish brown (2.5YR3/2)	6	12.5	0.0	0.0	2.46
2300 1250	---	---	Expanded	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

FLOATING TEST: Positive

REMARKS: Abrupt vitrification between 1100 and 1150°C.

BLOATING TEST (QUICK-FIRING):

Temp. (°F) (°C)	Bulk density (g/cc) (lb/ft ³)		% Absorb.	Remarks
1800 1000	1.77	110.3	14.5	Slight expansion.
1900 1050	1.60	100.1	10.2	Good pore structure.
2000 1100	1.29	80.2	9.4	Good pore structure.
2100 1150	0.95	59.1	12.8	Good pore structure (sticky).
2200 1200	--	--	--	--
2300 1250	--	--	--	--

REMARKS: Marginal lightweight aggregate. Short firing range.

POTENTIAL USES: Structural clay products (e.g., building brick at 1100°C). Marginal lightweight aggregate.

BLAIR COUNTY

ANTIS TOWNSHIP

TIPTON QUADRANGLE

SAMPLE NUMBER 86-B-8

LOCATION: Exposure along the northeast side of the roadway leading northwest from the village of Tipton to the Tipton Reservoir. Road distance from the railroad tracks in Tipton to this site is 2.4 miles (3.9 km).

LATITUDE: 40°39'21"N

LONGITUDE: 78°19'42"W

GEOLOGIC UNIT: Catskill Formation, Devonian

DESCRIPTION: Grayish-red (10R4/2), thin-bedded shale and silty shale are interbedded with a few thin-bedded sandstones. The sandstone units make up about 10 percent of the sequence. The shale breaks to form platy to hackly fragments, whereas the sandstone forms flaggy or slabby fragments. Effervescence occurred in some beds when treated with dilute HCl.

ATTITUDE OF BEDDING: N50E, 10NW

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Channel through 18 stratigraphic feet (6 m)

CHEMICAL ANALYSIS:

MINERALOGY (X-RAY):

	%
SiO ₂	62.7
Al ₂ O ₃	17.60
Σ"Fe ₂ O ₃ ".....	7.70
MgO.....	2.07
CaO.....	1.14
Na ₂ O.....	0.55
K ₂ O.....	4.43
TiO ₂	0.93
MnO.....	0.078
Total	97.20

	Weight %
Quartz	22
Mica-smectite	71
Kaolinite	0
Chlorite-vermiculite	2
Feldspar	4
Calcite	1

RAW PROPERTIES:

Water of plasticity (%): 13.7
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Fair
 pH: 7.8

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Brownish orange (2.5YR5/8)	3	2.5	9.8	20.4	2.09
1900	Grayish reddish orange (2.5YR5/6)	4	5.0	6.6	14.6	2.20
1050						
2000						
1100	---	---	Melted	---	---	---
2100						
1150	---	---	---	---	---	---
2200						
1200	---	---	---	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: ND

BLOATING TEST: Negative

REMARKS: Abrupt vitrification between 1050 and 1100°C. Presence of carbonates could cause problems.

POTENTIAL USES: Marginal for structural clay products (e.g., building brick at 1050°C).

BLAIR COUNTY

CITY OF ALTOONA

ALTOONA QUADRANGLE

SAMPLE NUMBER 86-C-6A

LOCATION: Borrow pit near the skating rink about 0.45 mile (760 m) north of Stevens School in the city of Altoona.

LATITUDE: 40°31'42"N

LONGITUDE: 78°22'53"W

GEOLOGIC UNIT: Marcellus Formation, Devonian

DESCRIPTION: Black (N1) fissile shale of the Marcellus Formation is exposed in this borrow pit.

ATTITUDE OF BEDDING: ---

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Channel through 14 feet (4 m) of stratigraphic section

CHEMICAL ANALYSIS:

	%
SiO ₂	63.6
Al ₂ O ₃	18.70
Σ"Fe ₂ O ₃ ".....	5.20
MgO.....	0.89
CaO.....	0.20
Na ₂ O.....	0.17
K ₂ O.....	4.07
TiO ₂	1.08
MnO.....	0.010
Total	93.92

MINERALOGY (X-RAY):

	Weight %
Quartz	28
Mica-smectite	66
Kaolinite	1
Chlorite-vermiculite	4
Feldspar	1
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 20.1
 Drying shrinkage (%): 2.5
 Workability: Plastic
 Dry strength: Fair
 pH: 7.2

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800 1000	Mod. yellowish pink (5YR8/4)	3	2.5	19.4	34.3	1.76
1900 1050	Mod. yellowish pink (5YR7/6)	3	2.5	15.5	29.1	1.87
2000 1100	Light brown (5YR6/6)	4	7.5	8.4	17.9	2.13
2100 1150	Light brown (5YR5/6)	4	10.0	2.9	6.7	2.32
2200 1200	Mod. brown (5YR4/4)	5	10.0	0.4	1.0	2.40
2300 1250	---	---	Melted	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Structural clay products (e.g., building brick at 1100-1150°C).

BLAIR COUNTY

CITY OF ALTOONA

ALTOONA QUADRANGLE

SAMPLE NUMBER 86-C-6B

LOCATION: Borrow pit near the skating rink about 0.45 mile (760 m) north of Stevens School in the city of Altoona.

LATITUDE: 40°31'42"N

LONGITUDE: 78°22'53"W

GEOLOGIC UNIT: Marcellus Formation, Devonian

DESCRIPTION: Black (N1) fissile shale of the Marcellus Formation is exposed in this borrow pit.

ATTITUDE OF BEDDING: ---

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Channel through 24.5 feet (7.5 m) of stratigraphic section

CHEMICAL ANALYSIS:

	%
SiO ₂	66.5
Al ₂ O ₃	17.05
Σ"Fe ₂ O ₃ ".....	5.26
MgO.....	0.90
CaO.....	0.21
Na ₂ O.....	0.14
K ₂ O.....	3.78
TiO ₂	0.92
MnO.....	0.011
Total	94.77

MINERALOGY (X-RAY):

	Weight %
Quartz	31
Mica-smectite	62
Kaolinite	5
Chlorite-vermiculite	0
Feldspar	1
Calcite	1

RAW PROPERTIES:

Water of plasticity (%): 20.0
 Drying shrinkage (%): 2.5
 Workability: Plastic
 Dry strength: Good
 pH: 7.2

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800 1000	Mod. yellowish pink (5YR8/4)	3	2.5	19.0	33.7	1.76
1900 1050	Mod. yellowish pink (5YR7/6)	3	2.5	15.2	28.5	1.87
2000 1100	Light brown (5YR6/6)	4	7.5	8.5	17.8	2.10
2100 1150	Light brown (5YR5/6)	4	10.0	3.2	7.3	2.27
2200 1200	Mod. brown (5YR4/4)	5	10.0	0.8	1.9	2.32
2300 1250	---	---	Melted	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Structural clay products (e.g., building brick at 1100-1150°C).

BLAIR COUNTY

ANTIS TOWNSHIP

BELLWOOD QUADRANGLE

SAMPLE NUMBER 86-D-7

LOCATION: Exposure along the Penn Central railroad tracks about 800 feet (245 m) south of the village of Fostoria.

LATITUDE: 40°36'58"N

LONGITUDE: 78°19'20"W

GEOLOGIC UNIT: Marcellus Formation, Devonian

DESCRIPTION: Black (N1) fissile shale from the lower part of the Marcellus Formation occurs in fault contact with sandstone and sandy limestone of the Ridgeley Formation. The presence of several bentonites interbedded with the shale is evidence that the interval represents the lower part of the Marcellus.

ATTITUDE OF BEDDING: N50E, vertical

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Channel through 15 feet (5 m) of stratigraphic section

CHEMICAL ANALYSIS:

	%
SiO ₂	62.1
Al ₂ O ₃	16.35
Σ"Fe ₂ O ₃ ".....	5.93
MgO.....	0.94
CaO.....	0.19
Na ₂ O.....	0.12
K ₂ O.....	4.04
TiO ₂	0.84
MnO.....	0.012
Total	90.52

MINERALOGY (X-RAY):

	Weight %
Quartz	34
Mica-smectite	62
Kaolinite	3
Chlorite-vermiculite	0
Feldspar	1
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 20.7
 Drying shrinkage (%): 5.0
 Workability: Short
 Dry strength: Fair
 pH: 7.0

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800	Mod. yellowish pink					
1000	(5YR8/4)	3	2.5	20.7	35.7	1.72
1900	Mod. yellowish pink					
1050	(5YR7/6)	3	2.5	17.2	31.3	1.82
2000						
1100	Light brown (5YR6/6)	4	7.5	11.6	23.0	1.98
2100						
1150	Light brown (5YR5/6)	4	10.0	5.4	11.8	2.18
2200						
1200	Mod. brown (5YR4/4)	5	10.0	2.6	5.9	2.25
2300						
1250	---	---	Melted	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Structural clay products (e.g., building brick at 1100-1200°C).

BLAIR COUNTY

TYRONE TOWNSHIP

BELLWOOD QUADRANGLE

SAMPLE NUMBER 86-D-9

LOCATION: Exposure along the west side of the road connecting the villages of Sickles Corner and Elberta, about 1.4 miles (2.3 km) south-southwest of Sickles Corner.

LATITUDE: 40°32'03"N

LONGITUDE: 78°17'40"W

GEOLOGIC UNIT: Reedsville Formation, Ordovician

DESCRIPTION: Olive-gray (5Y3/2), light-olive-brown (5Y5/6), and moderate-olive-brown (5Y4/4), interbedded, very thin to thin-bedded silty shale and shale are exposed at this locality. The silty shale predominates in the upper part of the sequence, which becomes more shaly with depth. The shale breaks to form hackly to platy fragments.

ATTITUDE OF BEDDING: N85E, 7SE

WEATHERING INTENSITY: Moderate to severe

SAMPLED INTERVAL: Channel through 15 stratigraphic feet (5 m)

CHEMICAL ANALYSIS:

MINERALOGY (X-RAY):

	%		Weight %
SiO ₂	59.5	Quartz	25
Al ₂ O ₃	17.40	Mica-smectite	67
Σ"Fe ₂ O ₃ ".....	8.00	Kaolinite	0
MgO.....	2.39	Chlorite-vermiculite	4
CaO.....	0.34	Feldspar	3
Na ₂ O.....	0.50	Calcite	1
K ₂ O.....	4.08		
TiO ₂	1.05		
MnO.....	0.099		
Total	93.36		

RAW PROPERTIES:

Water of plasticity (%): 17.7
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Fair
 pH: 7.1

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Deep orange (2.5YR5/10)	3	5.0	8.8	18.8	2.13
1900	Brownish orange					
1050	(2.5YR5/8)	4	7.5	4.7	10.7	2.28
2000						
1100	---	---	Melted	---	---	---
2100						
1150	---	---	---	---	---	---
2200						
1200	---	---	---	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: ND

BLOATING TEST: Negative

REMARKS: Abrupt vitrification between 1050 and 1100°C.

POTENTIAL USES: Marginal for structural clay products (e.g., building brick at 1050°C).

BLAIR COUNTY

FREEDOM TOWNSHIP

HOLLIDAYSBURG QUADRANGLE

SAMPLE NUMBER 87-A-4A

LOCATION: Shale pit operated by Charles L. Lingenfelter located about 1.25 miles (2.0 km) south by U. S. Route 220 from Newry, on the east side of that road.

LATITUDE: 40°22'32"N

LONGITUDE: 78°25'55"W

GEOLOGIC UNIT: Mahantango Formation, Devonian

DESCRIPTION: Olive-gray (5Y4/1), thin-bedded shale is exposed in this pit. The shale breaks to form platy fragments that range from less than 1 inch (3 cm) up to about 3 inches (8 cm) in their longest dimension. The platy fragments also have very angular edges. No effervescence occurred when tested with dilute HCl.

ATTITUDE OF BEDDING: N30W, 8SW

WEATHERING INTENSITY: Moderate

SAMPLED INTERVAL: Channel through 12 stratigraphic feet (3.7 m)

CHEMICAL ANALYSIS:

	%
SiO ₂	59.2
Al ₂ O ₃	18.65
Σ"Fe ₂ O ₃ ".....	7.10
MgO.....	1.69
CaO.....	0.24
Na ₂ O.....	0.67
K ₂ O.....	4.00
TiO ₂	1.08
MnO.....	0.061
Total	92.69

MINERALOGY (X-RAY):

	Weight %
Quartz	27
Mica-smectite	62
Kaolinite	0
Chlorite-vermiculite	7
Feldspar	4
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 16.0
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Fair
 pH: 7.2

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (5YR6/8)	3	5.0	10.9	22.7	2.08
1900	Brownish orange					
1050	(2.5YR5/8)	4	5.0	6.9	15.4	2.22
2000						
1100	---	---	Melted	---	---	---
2100						
1150	---	---	---	---	---	---
2200						
1200	---	---	---	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: ND

BLOATING TEST: Negative

REMARKS: Abrupt vitrification between 1050 and 1100°C.

POTENTIAL USES: Marginal for structural clay products (e.g., building brick at 1050°C).

BLAIR COUNTY

FREEDOM TOWNSHIP

HOLLIDAYSBURG QUADRANGLE

SAMPLE NUMBER 87-A-4B

LOCATION: Shale pit operated by Charles L. Lingenfelter located about 1.25 miles (2.0 km) south by U. S. Route 220 from Newry, on the east side of that road.

LATITUDE: 40°22'32"N

LONGITUDE: 78°25'55"W

GEOLOGIC UNIT: Mahantango Formation, Devonian

DESCRIPTION: Olive-gray (5Y4/1), medium-dark-gray (N4), and dark-gray (N3) interbedded shale, silty shale, and shaly siltstone occur stratigraphically above sample 87-A-4A. The shale and silty shale are thin bedded, whereas the siltstone is medium bedded. Shale predominates, making up between 60 and 70 percent of the sequence. The shapes of fragments representing the sequence are platy, slabby, and rubbly. A moderate amount of iron staining occurs along fractures and bedding planes.

ATTITUDE OF BEDDING: ---

WEATHERING INTENSITY: Moderate to slight

SAMPLED INTERVAL: Channel through 15 stratigraphic feet (5 m)

CHEMICAL ANALYSIS:

MINERALOGY (X-RAY):

ANALYSES NOT DONE BECAUSE SAMPLE HAS NO POTENTIAL USES

SiO ₂	Quartz
Al ₂ O ₃	Mica-smectite
Σ"Fe ₂ O ₃ ".....	Kaolinite
MgO.....	Chlorite-vermiculite
CaO.....	Feldspar
Na ₂ O.....	Calcite
K ₂ O.....	
TiO ₂	
MnO.....	
Total	

RAW PROPERTIES:
Water of plasticity (%): 15.5
Drying shrinkage (%): 2.5
Workability: Short
Dry strength: Fair
pH: 7.6

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (5YR6/8)	3	2.5	12.6	25.0	1.99
1900	Brownish orange					
1050	(2.5YR5/8)	3	5.0	10.2	21.2	2.08
2000						
1100	Strong brown (2.5YR4/6)	4	7.5	3.2	7.3	2.31
2100						
1150	---	---	Melted	---	---	---
2200						
1200	---	---	---	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: ND

BLOATING TEST: Negative

REMARKS: Abrupt vitrification between 1050 and 1100°C. Too soft at 1000-1050°C.

POTENTIAL USES: Not suitable for structural clay products.

BLAIR COUNTY

BLAIR TOWNSHIP

HOLLIDAYSBURG QUADRANGLE

SAMPLE NUMBER 87-A-5A

LOCATION: Shale pit operated by Russell C. Burket located about 0.55 mile (920 m) north-west of Newry and about 0.45 mile (770 m) east of the terminal building at the Blue Knob Valley Airport.

LATITUDE: 40°23'48"N

LONGITUDE: 78°26'47"W

GEOLOGIC UNIT: Mahantango Formation, Devonian

DESCRIPTION: Olive-gray (5Y4/1), very thin bedded, interbedded shale and silty shale within the upper part of the Mahantango Formation are exposed in this pit. The maximum thickness of any bed in this sequence measures about 1 inch (3 cm). Fragments of these rocks are predominantly platy in shape. The size of fragments ranges from about 2 inches (5 cm) up to more than 2 feet (0.6 m), the majority being smaller in size. Iron staining along fractures and bedding planes is present in low to moderate amounts.

ATTITUDE OF BEDDING: N5E, 1BNW

WEATHERING INTENSITY: Moderate

SAMPLED INTERVAL: Channel through 12 stratigraphic feet (3.7 m)

CHEMICAL ANALYSIS:

	%
SiO ₂	61.6
Al ₂ O ₃	16.95
Σ"Fe ₂ O ₃ ".....	6.33
MgO.....	1.80
CaO.....	0.37
Na ₂ O.....	0.69
K ₂ O.....	3.72
TiO ₂	1.03
MnO.....	0.076
Total	92.56

MINERALOGY (X-RAY):

	Weight %
Quartz	26
Mica-smectite	62
Kaolinite	0
Chlorite-vermiculite	7
Feldspar	5
Calcite	0

RAW PROPERTIES:

Water of plasticity (%):	14.6
Drying shrinkage (%):	2.5
Workability:	Short
Dry strength:	Fair
pH:	7.9

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (5YR6/8)	3	2.5	11.9	24.1	2.02
1900	Brownish orange (2.5YR5/8)	4	5.0	8.3	17.9	2.14
2000						
1100	Strong brown (2.5YR4/6)	5	7.5	1.4	3.3	2.40
2100						
1150	---	---	Melted	---	---	---
2200						
1200	---	---	---	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: ND

BLOATING TEST: Negative

REMARKS: Abrupt vitrification between 1050 and 1100°C. Presence of carbonates could cause problems.

POTENTIAL USES: Marginal for structural clay products (e.g., building brick at 1050°C).

BLAIR COUNTY

BLAIR TOWNSHIP

HOLLIDAYSBURG QUADRANGLE

SAMPLE NUMBER 87-A-5B

LOCATION: Shale pit operated by Russell C. Burket located about 0.55 mile (920 m) north-west of Newry and about 0.45 mile (770 m) east of the terminal building at the Blue Knob Valley Airport.

LATITUDE: 40°23'48"N

LONGITUDE: 78°26'47"W

GEOLOGIC UNIT: Mahantango Formation, Devonian

DESCRIPTION: Olive-gray (5Y4/1), very thin bedded, interbedded shale and silty shale occur stratigraphically above those sampled in 87-A-5A. This sequence also belongs in the upper part of the Mahantango Formation. Fragments of the shale and silty shale are platy. Iron staining in low to moderate amounts is present along fractures and bedding planes.

ATTITUDE OF BEDDING: N5E, 18NW

WEATHERING INTENSITY: Moderate

SAMPLED INTERVAL: Channel through 12 stratigraphic feet (4 m)

CHEMICAL ANALYSIS:

	%
SiO ₂	57.5
Al ₂ O ₃	19.00
Σ"Fe ₂ O ₃ ".....	7.30
MgO.....	2.12
CaO.....	0.28
Na ₂ O.....	0.57
K ₂ O.....	4.21
TiO ₂	1.03
MnO.....	0.072
Total	92.08

MINERALOGY (X-RAY):

	Weight %
Quartz	22
Mica-smectite	66
Kaolinite	0
Chlorite-vermiculite	10
Feldspar	2
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 16.0
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Fair
 pH: 7.9

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (5YR6/8)	3	2.5	11.7	23.9	2.04
1900	Brownish orange					
1050	(2.5YR5/8)	4	5.0	8.8	18.9	2.14
2000						
1100	Strong brown (2.5YR4/6)	5	7.5	1.4	3.4	2.40
2100						
1150	---	---	Melted	---	---	---
2200						
1200	---	---	---	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: ND

BLOATING TEST: Negative

REMARKS: Abrupt vitrification between 1050 and 1100°C. Presence of carbonates could cause problems.

POTENTIAL USES: Marginal for structural clay products (e.g., building brick at 1050°C).

BLAIR COUNTY

JUNIATA TOWNSHIP

HOLLIDAYSBURG QUADRANGLE

SAMPLE NUMBER 87-A-6

LOCATION: Abandoned shale pit located about 0.50 mile (830 m) northwest of Puzzletown on the east side of a medium-duty road.

LATITUDE: 40°23'01"N

LONGITUDE: 78°29'43"W

GEOLOGIC UNIT: Devonian marine units

DESCRIPTION: Light-olive-gray (5Y5/2), very thin to thin-bedded, interbedded shale and slightly silty shale are exposed in this pit. The maximum thickness measured for the beds in this sequence was about 2 inches (5 cm). The shale breaks to form predominantly platy fragments; a minor amount of splintery fragments are present. Iron staining is common along fractures and bedding planes.

ATTITUDE OF BEDDING: N15W, 8SW

WEATHERING INTENSITY: Moderate

SAMPLED INTERVAL: Channel through 15 stratigraphic feet (5 m)

CHEMICAL ANALYSIS:

	%
SiO ₂	63.0
Al ₂ O ₃	19.50
Σ"Fe ₂ O ₃ ".....	7.22
MgO.....	1.39
CaO.....	0.14
Na ₂ O.....	0.50
K ₂ O.....	4.15
TiO ₂	0.99
MnO.....	0.092
Total	96.98

MINERALOGY (X-RAY):

	Weight %
Quartz	30
Mica-smectite	66
Kaolinite	0
Chlorite-vermiculite	3
Feldspar	1
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 16.7
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Fair
 pH: 7.5

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (5YR6/8)	3	2.5	12.4	24.8	2.00
1900						
1050	Brownish orange (2.5YR5/8)	4	5.0	8.6	18.5	2.15
2000						
1100	Strong brown (2.5YR4/6)	5	7.5	2.4	5.8	2.40
2100						
1150	---	---	Melted	---	---	---
2200						
1200	---	---	---	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Structural clay products (e.g., building brick at 1050-1100°C).

BLAIR COUNTY

BLAIR TOWNSHIP

HOLLIDAYSBURG QUADRANGLE

SAMPLE NUMBER 87-A-7

LOCATION: Exposure of Mahantango shale along the west side of Pa. Route 36, about 4 miles (6.4 km) north-northwest of Roaring Springs and about 0.55 mile (920 m) northwest of the village of Brooks Mills.

LATITUDE: 40°22'49"N

LONGITUDE: 78°25'04"W

GEOLOGIC UNIT: Mahantango Formation, Devonian

DESCRIPTION: Grayish-black (N2), fissile shale is exposed at this location. The shale breaks to form papery to platy fragments. Iron staining is common along fractures and bedding planes. Siderite nodules occur in a few places in the sampled interval; the largest nodule measured about 6 inches (15 cm).

ATTITUDE OF BEDDING: N30E, 5SE

WEATHERING INTENSITY: Moderate to severe

SAMPLED INTERVAL: Composite representing 18 stratigraphic feet (6 m)

CHEMICAL ANALYSIS:

MINERALOGY (X-RAY):

	%
SiO ₂	59.0
Al ₂ O ₃	20.45
Σ"Fe ₂ O ₃ ".....	7.08
MgO.....	1.81
CaO.....	0.25
Na ₂ O.....	0.63
K ₂ O.....	4.05
TiO ₂	0.99
MnO.....	0.043
Total	94.30

	Weight %
Quartz	24
Mica-smectite	68
Kaolinite	0
Chlorite-vermiculite	5
Feldspar	3
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 13.9
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Fair
 pH: 7.1

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (5YR6/8)	3	2.5	11.6	23.2	2.00
1900						
1050	Mod. orange (2.5YR6/8)	4	5.0	8.2	17.4	2.13
2000						
1100	Strong brown (2.5YR4/6)	5	5.0	3.8	8.3	2.18
2100						
1150	---	---	Melted	---	---	---
2200						
1200	---	---	---	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Positive

REMARKS: ---

BLOATING TEST (QUICK-FIRING):

Temp. (°F) (°C)	Bulk density ³ (g/cc) (lb/ft ³)		% Absorb.	Remarks
1800 1000	--	--	--	--
1900 1050	--	--	--	--
2000 1100	1.46	91.1	14.3	Partial expansion.
2100 1150	1.29	80.5	16.4	Partial expansion.
2200 1200	0.87	54.3	14.8	Good pore structure (sticky).
2300 1250	0.61	37.9	25.8	Overfired.

REMARKS: Marginal for lightweight aggregate (1200°C). Short firing range.

POTENTIAL USES: Structural clay products (e.g., building brick at 1050-1100°C).
Marginal for lightweight aggregate.

BLAIR COUNTY

HUSTON TOWNSHIP

FRANKSTOWN QUADRANGLE

SAMPLE NUMBER 87-B-2

LOCATION: Inactive clay pit owned by the Woodbury Clay Company and known as Oreminea 1, located about 0.85 mile (1.38 km) south-southwest of Oreminea.

LATITUDE: 40°23'31"N

LONGITUDE: 78°15'38"W

GEOLOGIC UNIT: Gatesburg Formation, Cambrian

DESCRIPTION: An elliptical-shaped clay deposit which was mined in the past. The dimensions of the mined-out pit are about 1,000 feet (300 m) in length, 500 feet (150 m) in width, and 100 feet (30 m) in depth. The origin of this clay deposit has been interpreted as the filling of a sinkhole with clayey material derived from the weathering of overlying Gatesburg dolomite. The clayey material was subsequently leached of potassium, iron, and some silicon by waters saturated with carbon dioxide, carbonic acid, and humic acid (Hosterman, 1972).

ATTITUDE OF BEDDING: ---

WEATHERING INTENSITY: Severe

SAMPLED INTERVAL: Grab sample of white clay from the "lower level" of the pit

CHEMICAL ANALYSIS:		MINERALOGY (X-RAY):	
	%		Weight %
SiO ₂	>72	Quartz	70
Al ₂ O ₃	17.40	Mica-smectite	9
Σ"Fe ₂ O ₃ ".....	0.60	Kaolinite	20
MgO.....	0.24	Chlorite-vermiculite	0
CaO.....	0.00	Feldspar	1
Na ₂ O.....	0.02	Calcite	0
K ₂ O.....	0.57	RAW PROPERTIES: Water of plasticity (%): 22.6 Drying shrinkage (%): 2.5 Workability: Plastic Dry strength: Fair pH: 5.9	
TiO ₂	0.83		
MnO.....	0.004		
Total > 91.66			

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800 1000	White	3	2.5	24.2	38.8	1.61
1900 1050	White	3	2.5	24.0	38.7	1.61
2000 1100	White	3	2.5	23.5	37.8	1.61
2100 1150	White	3	2.5	21.8	36.6	1.68
2200 1200	White	3	2.5	20.8	35.5	1.70
2300 1250	White	5	5.0	16.7	29.9	1.80

PYROMETRIC CONE EQUIVALENT: 27 (1650°C)
(3000°F)

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Structural clay products (e.g., structural tile at 1250°C; medium-duty refractories. Could be used also in whiteware bodies.

BLAIR COUNTY

HUSTON TOWNSHIP

FRANKSTOWN QUADRANGLE

SAMPLE NUMBER 87-B-3

LOCATION: Inactive clay pit owned by the Woodbury Clay Company and known as Oreminea 1, located about 0.85 mile (1.38 km) south-southwest of Oreminea.

LATITUDE: 40°23'33"N

LONGITUDE: 78°15'38"W

GEOLOGIC UNIT: Gatesburg Formation, Cambrian

DESCRIPTION: An elliptical-shaped clay deposit which was mined in the past. The dimensions of the mined-out pit now measure about 1,000 feet (300 m) in length, 500 feet (150 m) in width, and 100 feet (30 m) in depth. The origin of the clay has been interpreted as the filling of a sinkhole with clayey material derived from the weathering of overlying Gatesburg dolomite. The clayey material was subsequently leached of potassium, iron, and some silicon by waters saturated with carbon dioxide (carbonic acid) and humic acid (Hosterman, 1972).

ATTITUDE OF BEARING: ---

WEATHERING INTENSITY: Severe

SAMPLED INTERVAL: Grab sample of clay from the "higher level" of the pit

CHEMICAL ANALYSIS:

	%
SiO ₂	>75
Al ₂ O ₃	9.45
Σ"Fe ₂ O ₃ ".....	0.64
MgO.....	0.30
CaO.....	0.00
Na ₂ O.....	0.02
K ₂ O.....	0.68
TiO ₂	0.40
MnO.....	0.007
Total	>86.50

MINERALOGY (X-RAY):

	Weight %
Quartz	80
Mica-smectite	5
Kaolinite	15
Chlorite-vermiculite	0
Feldspar	0
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 13.7
 Drying shrinkage (%): 2.5
 Workability: Plastic
 Dry strength: Fair
 pH: 6.1

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	White (5YR9/1)	3	2.5	15.8	29.2	1.84
1900						
1050	White (5YR9/1)	3	2.5	15.8	29.1	1.85
2000						
1100	White (5YR9/1)	3	2.5	15.5	28.8	1.86
2100						
1150	White (10YR9/1)	4	2.5	14.3	27.0	1.88
2200						
1200	White (10YR9/1)	5	2.5	13.5	25.7	1.90
2300						
1250	White (10YR9/1)	5	2.5	12.0	23.0	1.92

PYROMETRIC CONE EQUIVALENT: ND

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Structural clay products (e.g., floor brick, structural tile at 1150-1250°C).

BLAIR COUNTY

NORTH WOODBURY TOWNSHIP

MARTINSBURG QUADRANGLE

SAMPLE NUMBER 87-D-8

LOCATION: Inactive pit along the east side of Pa. Route 164 about 1 mile (1.6 km) by road from the village of Clover Creek.

LATITUDE: 40°17'49"N

LONGITUDE: 78°16'10"W

GEOLOGIC UNIT: Reedsville Formation, Ordovician

DESCRIPTION: Light-olive-gray (5Y5/2) to grayish-olive (10Y4/2), interbedded thin-bedded shale and silty shale were collected on the south side of this pit. The shale breaks easily to form angular, platy- to block-shaped fragments which range in long dimension from less than 1 inch (3 cm) up to 18 inches (46 cm). Most fragments are from 1 to 2 inches (3 to 5 cm) long. Iron and manganese staining in moderate amounts occurs along fractures and bedding planes. Talus, estimated to be about 10 feet (3 m) thick, overlies the sampled interval.

ATTITUDE OF BEDDING: N8E, 30SE

WEATHERING INTENSITY: Moderate

SAMPLED INTERVAL: Composite representing 30 stratigraphic feet (9 m)

CHEMICAL ANALYSIS:

MINERALOGY (X-RAY):

	%		Weight %
SiO ₂	60.0	Quartz	19
Al ₂ O ₃	16.90	Mica-smectite	77
Σ"Fe ₂ O ₃ ".....	7.93	Kaolinite	0
MgO.....	2.20	Chlorite-vermiculite	3
CaO.....	0.26	Feldspar	1
Na ₂ O.....	0.47	Calcite	0
K ₂ O.....	3.80		
TiO ₂	1.05		
MnO.....	0.087		
Total	92.70		

RAW PROPERTIES:

Water of plasticity (%): 17.8
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Fair
 pH: 7.5

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800 1000	Mod. orange (2.5YR6/8)	3	5.0	10.5	21.5	2.04
1900 1050	Brownish orange (2.5YR5/8)	4	7.5	6.6	14.5	2.19
2000 1100	Strong brown (2.5YR4/6)	5	10.0	2.2	5.3	2.37
2100 1150	---	---	Melted	---	---	---
2200 1200	---	---	---	---	---	---
2300 1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Structural clay products (e.g., building brick at 1050-1100°C).

BLAIR COUNTY

HUSTON TOWNSHIP

MARTINSBURG QUADRANGLE

SAMPLE NUMBER 87-D-9

LOCATION: Clay pit formerly operated by the Fair Valley Clay Company of Altoona, located about 3 miles (4.8 km) northeast of Martinsburg.

LATITUDE: 40°19'55"N

LONGITUDE: 78°16'35"W

GEOLOGIC UNIT: Gatesburg Formation, Cambrian

DESCRIPTION: Mottled moderate-yellowish-brown (10YR5/4) and light-gray (N7) clay is stockpiled along the fringes of this pit. The Fair Valley Clay Company of Altoona dug clay here during the 1940's. It was previously the site of an iron (limonite) mine. The pit now measures about 500 feet (150 m) in length and about 200 feet (60 m) in width, and is estimated to be more than 25 feet (8 m) deep. Reserves of clay in the stockpiles that border this pit appear to be relatively small.

ATTITUDE OF BEDDING: ---

WEATHERING INTENSITY: Moderate

SAMPLED INTERVAL: Grab sample collected from waste pile

CHEMICAL ANALYSIS:

	%
SiO ₂	>72
Al ₂ O ₃	15.00
Σ"Fe ₂ O ₃ ".....	0.80
MgO.....	0.34
CaO.....	0.03
Na ₂ O.....	0.03
K ₂ O.....	0.75
TiO ₂	0.62
MnO.....	0.002
Total >89.57	

MINERALOGY (X-RAY):

	Weight %
Quartz	68
Mica-smectite	10
Kaolinite	22
Chlorite-vermiculite	0
Feldspar	0
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 20.5
 Drying shrinkage (%): 2.5
 Workability: Plastic
 Dry strength: Fair
 pH: 6.7

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800 1000	White	2	2.5	22.1	36.8	1.66
1900 1050	White	2	2.5	22.0	36.8	1.67
2000 1100	White	2	2.5	21.1	36.0	1.71
2100 1150	White	2	2.5	19.2	33.6	1.75
2200 1200	White	3	2.5	17.4	31.7	1.82
2300 1250	White	3	5.0	15.6	28.7	1.84

PYROMETRIC CONE EQUIVALENT: 26

BLOATING TEST: Negative

REMARKS: Not suitable for structural clay products. Too soft.

POTENTIAL USES: Low-duty refractories.

BLAIR COUNTY

NORTH WOODBURY TOWNSHIP

MARTINSBURG QUADRANGLE

SAMPLE NUMBER 87-D-10

LOCATION: Clay pit formerly operated by the Fair Valley Clay Company of Altoona, located about 2 miles (3.2 km) northeast of Martinsburg.

LATITUDE: 40°19'14"N

LONGITUDE: 78°17'17"W

GEOLOGIC UNIT: Gatesburg Formation, Cambrian

DESCRIPTION: Mottled moderate-yellowish-brown (10YR5/4) and light-gray (N7) clay is present in waste piles located southeast of the pit. The pit is at least 400 feet (120 m) long and 200 feet (60 m) wide, and its walls show many different colors of clay, along with sand and limonite geodes. This clay pit was reportedly worked out in 1940. The reserves of clay remaining in the stockpiles are relatively small.

ATTITUDE OF BEDDING: ---

WEATHERING INTENSITY: Moderate

SAMPLED INTERVAL: Grab sample collected from waste pile

CHEMICAL ANALYSIS:

	%
SiO ₂	~72
Al ₂ O ₃	20.45
Σ"Fe ₂ O ₃ ".....	0.32
MgO.....	0.27
CaO.....	0.00
Na ₂ O.....	0.03
K ₂ O.....	0.68
TiO ₂	0.76
MnO.....	0.002
Total	~94.51

MINERALOGY (X-RAY):

	Weight %
Quartz	47
Mica-smectite	7
Kaolinite	46
Chlorite-vermiculite	0
Feldspar	0
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 23.1
 Drying shrinkage (%): 2.5
 Workability: Plastic
 Dry strength: Fair
 pH: 6.6

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	White	2	2.5	24.6	40.0	1.60
1900						
1050	White	2	2.5	25.0	39.5	1.61
2000						
1100	White	2	2.5	23.8	38.6	1.62
2100						
1150	White	2	2.5	22.0	36.8	1.67
2200						
1200	White	3	5.0	20.4	35.3	1.73
2300						
1250	White	3	5.0	17.7	35.3	1.82

PYROMETRIC CONE EQUIVALENT: 30

BLOATING TEST: Negative

REMARKS: Not suitable for structural clay products. Too soft.

POTENTIAL USES: Medium-duty refractories.

BLAIR COUNTY

NORTH WOODBURY TOWNSHIP

MARTINSBURG QUADRANGLE

SAMPLE NUMBER 87-D-11

LOCATION: Small pit located southeast of the road connecting the villages of Clover Creek and Millerstown, about 0.50 mile (800 m) north-northeast of Millerstown.

LATITUDE: 40°17'06"N

LONGITUDE: 78°17'40"W

GEOLOGIC UNIT: Axemann and Bellefonte Formations, Ordovician

DESCRIPTION: Moderate reddish-brown (10R4/6), "high-iron" clay developed in and around an old pit that is currently being used to dispose of solid wastes. This clay is probably a residual deposit developed from weathering of carbonate rocks in the underlying geologic unit(s).

ATTITUDE OF BEDDING: ---

WEATHERING INTENSITY: Severe

SAMPLED INTERVAL: Grab sample collected along the east side of the road

CHEMICAL ANALYSIS:

	%
SiO ₂	46.5
Al ₂ O ₃	15.15
Σ"Fe ₂ O ₃ ".....	21.00
MgO.....	1.84
CaO.....	1.13
Na ₂ O.....	0.08
K ₂ O.....	2.28
TiO ₂	0.63
MnO.....	0.073
Total	88.68

MINERALOGY (X-RAY):

	Weight %
Quartz	20*
Mica-smectite	55*
Kaolinite	7
Chlorite-vermiculite	1
Feldspar	2
Calcite	0
Goethite	10*
Dolomite	5*

RAW PROPERTIES:

Water of plasticity (%):	21.4
Drying shrinkage (%):	2.5
Workability:	Plastic
Dry strength:	Good
pH:	8.1

SLOW-FIRING TESTS:

*Estimates

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800 1000	Brownish orange (2.5YR5/8)	4	10.0	6.2	14.8	2.41
1900 1050	Strong brown (2.5YR4/8)	4	12.5	3.5	8.8	2.49
2000 1100	Strong brown (2.5YR4/6)	5	12.5	2.4	5.9	2.50
2100 1150	---	---	Melted	---	---	---
2200 1200	---	---	---	---	---	---
2300 1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Presence of carbonates could cause problems.

POTENTIAL USES: Structural clay products (e.g., building brick, floor brick at 1000-1100°C).

CENTRE COUNTY

RUSH TOWNSHIP

HOUTZDALE QUADRANGLE

SAMPLE NUMBER 85-D-1

LOCATION: Elliot Coal Company stripping operation located about 2.3 miles (3.7 km) south-southeast of Osceola Mills.

LATITUDE: 40°49'20"N

LONGITUDE: 78°15'10"W

GEOLOGIC UNIT: Allegheny Group, Pennsylvanian

DESCRIPTION: Grayish-black (N2) to black (N1) fissile shale occurs for a stratigraphic interval of 20 feet (6 m) above the Lower Kittanning coal. The shale breaks down to form papery to platy fragments. Iron staining is common along fractures and bedding planes.

ATTITUDE OF BEDDING: Essentially horizontal

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Channel sample through 10 feet (3 m) of stratigraphic section above the Lower Kittanning coal

CHEMICAL ANALYSIS:

	%
SiO ₂	54.2
Al ₂ O ₃	20.50
Σ"Fe ₂ O ₃ ".....	7.10
MgO.....	1.56
CaO.....	0.21
Na ₂ O.....	0.23
K ₂ O.....	3.60
TiO ₂	0.95
MnO.....	0.141
Total	88.49

MINERALOGY (X-RAY):

	Weight %
Quartz	22
Mica-smectite	51
Kaolinite	18
Chlorite-vermiculite	7
Feldspar	2
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 13.2
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Fair
 pH: 6.2

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (5YR6/6)	5	2.5	13.9	27.7	1.98
1900						
1050	Strong brown (2.5YR4/6)	5	5.0	7.8	17.3	2.22
2000						
1100	Mod. reddish brown (2.5YR3/4)	7	5.0	3.7	8.7	2.37
2100						
1150	Grayish reddish brown (2.5YR3/2)	7	7.5	1.5	3.7	2.44
2200						
1200	---	---	Melted	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Facing brick at 1050-1100°C.

CENTRE COUNTY

RUSH TOWNSHIP

HOUTZDALE QUADRANGLE

SAMPLE NUMBER 85-D-2A

LOCATION: Elliot Coal Company stripping operation located about 1.5 miles (2.45 km) southwest of the center of Osceola Mills.

LATITUDE: 40°50'10"N

LONGITUDE: 78°17'24"W

GEOLOGIC UNIT: Allegheny Group, Pennsylvanian

DESCRIPTION: Medium-dark-gray (N4) to grayish-black (N2), thin-bedded shale occurs stratigraphically above the Middle Kittanning coal for a distance of 14 feet (4.3 m). Massive sandstones occur directly above the shale. The shale becomes slightly silty in the upper part, and breaks to form platy to slabby fragments. Moderate-yellowish-brown (10YR5/4) iron staining is present in minor amounts along the fractures and bedding planes in the shale.

ATTITUDE OF BEDDING: Essentially horizontal

WEATHERING INTENSITY: Slight

SAMPLED INTERVAL: Channel sample through 14 feet (4.3 m) of shale

CHEMICAL ANALYSIS:

	%
SiO ₂	55.5
Al ₂ O ₃	19.25
Σ"Fe ₂ O ₃ ".....	7.40
MgO.....	1.70
CaO.....	0.38
Na ₂ O.....	0.22
K ₂ O.....	3.94
TiO ₂	0.91
MnO.....	0.123
Total	89.42

MINERALOGY (X-RAY):

	Weight %
Quartz	21
Mica-smectite	64
Kaolinite	7
Chlorite-vermiculite	7
Feldspar	1
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 16.0
 Drying shrinkage (%): 5.0
 Workability: Short
 Dry strength: Fair
 pH: 6.4

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (5YR6/6)	3	5.0	12.2	24.2	1.99
1900						
1050	Strong brown (2.5YR4/6)	5	7.5	7.8	16.8	2.15
2000	Mod. reddish brown (2.5YR4/4)	6	7.5	5.9	13.0	2.21
1100						
2100						
1150	---	---	Melted	---	---	---
2200						
1200	---	---	---	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Abrupt vitrification (1100-1150°C).

POTENTIAL USES: Facing brick at 1050°C.

CENTRE COUNTY

RUSH TOWNSHIP

HOUTZDALE QUADRANGLE

SAMPLE NUMBER 85-D-2B

LOCATION: Elliot Coal Company stripping operation located about 1.5 miles (2.45 km) southwest of the center of Osceola Mills.

LATITUDE: 40°50'10"N

LONGITUDE: 78°17'24"W

GEOLOGIC UNIT: Allegheny Group, Pennsylvanian

DESCRIPTION: Medium-dark-gray (N4) to dark-gray (N3) underclay to the Middle Kittanning coal is partially exposed in the floor of the strip pit. Sample collected represents only the upper 6 inches (15 cm) of the underclay.

ATTITUDE OF BEDDING: Essentially horizontal

WEATHERING INTENSITY: Slight

SAMPLED INTERVAL: Grab sample of upper part of the underclay to the Middle Kittanning coal

CHEMICAL ANALYSIS:		MINERALOGY (X-RAY):	
	%		Weight %
SiO ₂	54.9	Quartz	19
Al ₂ O ₃	21.90	Mica-smectite	63
Σ"Fe ₂ O ₃ ".....	5.45	Kaolinite	17
MgO.....	1.15	Chlorite-vermiculite	1
CaO.....	1.03	Feldspar	0
Na ₂ O.....	0.14	Calcite	0
K ₂ O.....	3.66		
TiO ₂	1.15		
MnO.....	0.052		
Total	89.43		

RAW PROPERTIES:

Water of plasticity (%): 11.2

Drying shrinkage (%): 2.5

Workability: Short

Dry strength: Fair

pH: 4.4

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Brownish orange (5YR5/6)	7	7.5	6.0	13.7	2.27
1900						
1050	Mod. brown (5YR4/4)	7.5	10.0	1.7	4.1	2.43
2000						
1100	---	---	Melted	---	---	---
2100						
1150	---	---	---	---	---	---
2200						
1200	---	---	---	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Abrupt vitrification (1000-1050°C).

POTENTIAL USES: Facing brick at <1000°C.

CENTRE COUNTY

RUSH TOWNSHIP

HOUTZDALE QUADRANGLE

SAMPLE NUMBER 85-D-3A

LOCATION: Elliot Coal Company stripping operation located about 1.25 miles (2.00 km) west of Penn Five and about 1.5 miles (2.45 km) southwest of Edendale.

LATITUDE: 40°49'38"N

LONGITUDE: 78°17'34"W

GEOLOGIC UNIT: Allegheny Group, Pennsylvanian

DESCRIPTION: Medium-dark-gray (N4) to dark-gray (N3), thin-bedded shale occurs for a distance of 15 feet (4.6 m) above the Middle Kittanning coal. A fine-grained sandstone occurs stratigraphically above the shale. The shale breaks into slabby fragments. Dark-yellowish-orange (10YR6/6) iron staining is present in minor amounts along fractures and bedding planes in the shale.

ATTITUDE OF BEDDING: Essentially horizontal

WEATHERING INTENSITY: Slight

SAMPLED INTERVAL: Channel sample from 0 to 10 feet (0 to 3 m) above the Middle Kittanning coal

CHEMICAL ANALYSIS:

MINERALOGY (X-RAY):

	%		Weight %
SiO ₂	48.8	Quartz	13
Al ₂ O ₃	20.05	Mica-smectite	57
Σ"Fe ₂ O ₃ ".....	10.15	Kaolinite	28
MgO.....	1.80	Chlorite-vermiculite	1
CaO.....	0.53	Feldspar	1
Na ₂ O.....	0.23	Calcite	0
K ₂ O.....	3.72		
TiO ₂	0.80		
MnO.....	0.208		
Total	86.29		

RAW PROPERTIES:

Water of plasticity (%): 16.0
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Fair
 pH: 6.2

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (5YR6/6)	5	5.0	12.0	24.1	2.02
1900	Mod. reddish brown					
1050	(2.5YR4/4)	5	7.5	7.0	15.6	2.21
2000	Mod. reddish brown					
1100	(2.5YR3/4)	6	10.0	4.9	11.1	2.25
2100						
1150	---	---	Melted	---	---	---
2200						
1200	---	---	---	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

SLOATING TEST: Negative

REMARKS: Abrupt vitrification (1100-1150°C).

POTENTIAL USES: Facing brick at 1000-1050°C.

CENTRE COUNTY

RUSH TOWNSHIP

HOUTZDALE QUADRANGLE

SAMPLE NUMBER 85-D-3B

LOCATION: Elliot Coal Company stripping operation located about 1.3 miles (2.15 km) southwest of Edendale and about 1.4 miles (2.3 km) south of Coal Run Junction.

LATITUDE: 40°49'42"N

LONGITUDE: 78°17'24"W

GEOLOGIC UNIT: Allegheny Group, Pennsylvanian

DESCRIPTION: Dark-gray (N3) to grayish-black (N2), thin-bedded shale grades stratigraphically upward to fissile shale. Sandstone beds occur directly above the sampled interval of shale, which measures 8 feet (2.45 m). Pale-yellowish-orange (10YR8/6) to moderate-yellowish-brown (10YR5/4) iron staining is present in moderate amounts along fractures and bedding planes in the shale. The shale breaks to form platy to slabby fragments.

ATTITUDE OF BEDDING: Essentially horizontal

WEATHERING INTENSITY: Slight

SAMPLED INTERVAL: Channel sample from 0 to 8 feet (0 to 2.45 m) above the Upper Kittanning coal

CHEMICAL ANALYSIS:

MINERALOGY (X-RAY):

	%
SiO ₂	57.8
Al ₂ O ₃	20.55
Σ"Fe ₂ O ₃ ".....	6.50
MgO.....	1.72
CaO.....	0.10
Na ₂ O.....	0.24
K ₂ O.....	3.97
TiO ₂	0.86
MnO.....	0.046
Total	91.78

	Weight %
Quartz	23
Mica-smectite	55
Kaolinite	14
Chlorite-vermiculite	7
Feldspar	1
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 17.6
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Fair
 pH: 5.2

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (5YR6/8)	3	2.5	16.0	30.7	1.92
1900						
1050	Brownish orange (2.5YR5/8)	5	5.0	12.0	24.0	2.00
2000						
1100	Strong brown (2.5YR4/6)	6	5.0	7.9	17.2	2.19
2100	Mod. reddish brown					
1150	(2.5YR3/4)	7	7.5	3.8	8.9	2.34
2200	Grayish reddish brown					
1200	(2.5YR3/2)	8	7.5	1.4	3.3	2.41
2300						
1250	---	---	Melted	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Good firing range.

POTENTIAL USES: Facing brick at 1050-1150°C.

CENTRE COUNTY

RUSH TOWNSHIP

HOUTZDALE QUADRANGLE

SAMPLE NUMBER 85-D-3C

LOCATION: Elliot Coal Company stripping operation located about 1.3 miles (2.15 km) southwest of Edendale and about 1.4 miles (2.3 km) south of Coal Run Junction.

LATITUDE: 40°49'42"N

LONGITUDE: 78°17'24"W

GEOLOGIC UNIT: Allegheny Group, Pennsylvanian

DESCRIPTION: Medium-dark-gray (N4) to dark-gray (N3) underclay to the Upper Kittanning coal is partially exposed for a stratigraphic thickness of 21 inches (53 cm) in a drainage ditch in the strip mine. Although the thickness of the underclay exceeds that exposed in the mine, it is reported to be relatively thin in this area. The underclay breaks to form blocky to rubbly fragments. Dark-yellowish-orange (10YR6/6) to moderate-yellowish-brown (10YR5/4) iron staining is present in minor amounts along fractures in the underclay.

ATTITUDE OF BEDDING: Essentially horizontal

WEATHERING INTENSITY: Slight

SAMPLED INTERVAL: Channel sample through 21 inches (53 cm) of underclay

CHEMICAL ANALYSIS:

	%
SiO ₂	60.5
Al ₂ O ₃	20.40
Σ"Fe ₂ O ₃ ".....	2.95
MgO.....	1.20
CaO.....	0.18
Na ₂ O.....	0.14
K ₂ O.....	3.38
TiO ₂	1.06
MnO.....	0.034
Total	89.84

MINERALOGY (X-RAY):

	Weight %
Quartz	23
Mica-smectite	60
Kaolinite	15
Chlorite-vermiculite	2
Feldspar	0
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 11.2
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Fair
 pH: 6.9

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (5YR7/6)	6	2.5	10.3	21.6	2.09
1900						
1050	Mod. orange (5YR6/6)	7	5.0	5.5	12.5	2.28
2000						
1100	Brownish orange (5YR5/6)	7.5	5.0	3.8	8.7	2.32
2100						
1150	Mod. brown (7.5YR4/4)	8	7.5	1.7	4.0	2.39
2200						
1200	Grayish yellowish brown (10YR4/2)	8	7.5	0.9	2.2	2.41
2300						
1250	---	---	Melted	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Good firing range.

POTENTIAL USES: Facing brick, facing tile at 1000-1150°C.

CENTRE COUNTY

RUSH TOWNSHIP

HOUTZDALE QUADRANGLE

SAMPLE NUMBER 85-D-4A

LOCATION: Elliot Coal Company stripping operation located about 1.5 miles (2.45 km) southwest of Edendale and about 1.5 miles (2.45 km) south-southwest of Earnestville.

LATITUDE: 40°49'24"N

LONGITUDE: 78°15'34"W

GEOLOGIC UNIT: Pottsville Group, Pennsylvanian

DESCRIPTION: Medium-light-gray (N6) to medium-gray (N5) underclay to the Brookville coal is partially exposed for a stratigraphic interval of 43 inches (109 cm) in the strip mine. Plant debris and a slight amount of iron staining are present in the underclay. The underclay breaks to form hackly to rubbly fragments. Sandstone beds occur above the Brookville coal.

ATTITUDE OF BEDDING: Essentially horizontal

WEATHERING INTENSITY: Negligible

SAMPLED INTERVAL: Channel sample through 43 inches (109 cm) of underclay

CHEMICAL ANALYSIS:

MINERALOGY (X-RAY):

	%
SiO ₂	53.6
Al ₂ O ₃	27.70
Σ"Fe ₂ O ₃ ".....	2.05
MgO.....	0.75
CaO.....	0.14
Na ₂ O.....	0.27
K ₂ O.....	3.75
TiO ₂	1.62
MnO.....	0.006
Total	89.89

	Weight %
Quartz	13
Mica-smectite	49
Kaolinite	37
Chlorite-vermiculite	0
Feldspar	1
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 13.0
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Fair
 pH: 4.3

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800 1000	Pale yellowish pink (7.5YR9/2)	3	2.5	14.8	28.7	1.94
1900 1050	Pale orange yellow (10YR8/4)	6	5.0	9.0	19.5	2.16
2000 1100	Pale orange yellow (10YR8/4)	7	7.5	6.6	15.0	2.26
2100 1150	Light yellowish brown (10YR7/4)	7	7.5	4.3	10.0	2.33
2200 1200	Grayish yellow (2.5Y7/4)	7	7.5	4.0	9.4	2.34
2300 1250	Light olive brown	7	7.5	1.5	3.7	2.38

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Good firing range.

POTENTIAL USES: Facing brick, facing tile at 1050-1200°C.

INDIVIDUAL SAMPLE DATA, CENTRE COUNTY

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CENTRE COUNTY

HUSTON TOWNSHIP

PORT MATILDA QUADRANGLE

SAMPLE NUMBER 95-D-1A

LOCATION: Shale pit located about 0.65 mile (1.05 km) northeast of the church in Martha Furnace.

LATITUDE: 40°50'20"N

LONGITUDE: 78°00'09"W

GEOLOGIC UNIT: Hamilton Group, Devonian

DESCRIPTION: Dark-gray (N3), very thin bedded shale is exposed in this shale pit. The shale breaks down to form platy to flaggy fragments. Sample collected represents 34 feet (10 m) of shale; about 6 feet (1.8 m) of the shale sequence is quite carbonaceous. Sampling started at the northern part of the exposure. Light- to moderate-brown (5YR5/6 to 5YR4/4) iron staining is common along fractures and bedding planes.

ATTITUDE OF BEDDING: N45E, 26NW

WEATHERING INTENSITY: Slight

SAMPLED INTERVAL: Composite representing 34 feet (10 m) of section

CHEMICAL ANALYSIS:

	%
SiO ₂	61.4
Al ₂ O ₃	17.70
Σ"Fe ₂ O ₃ ".....	5.75
MgO.....	1.77
CaO.....	0.12
Na ₂ O.....	0.62
K ₂ O.....	4.13
TiO ₂	0.98
MnO.....	0.039
Total	92.51

MINERALOGY (X-RAY):

	Weight %
Quartz	24
Mica-smectite	67
Kaolinite	0
Chlorite-vermiculite	5
Feldspar	4
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 15.4
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Fair
 pH: 5.5

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (5YR6/8)	5	2.5	11.2	23.0	2.06
1900						
1050	Strong brown (2.5YR4/6)	6	5.0	4.5	10.3	2.30
2000						
1100	Mod. reddish brown (2.5YR3/4)	7	7.5	1.9	4.3	2.31
2100						
1150	---	---	Melted	---	---	---
2200						
1200	---	---	---	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: ND

BLOATING TEST: Negative

REMARKS: Abrupt vitrification (1050-1100°C).

POTENTIAL USES: Facing brick at 1050°C and below.

CENTRE COUNTY

HUSTON TOWNSHIP

PORT MATILDA QUADRANGLE

SAMPLE NUMBER 95-D-1B

LOCATION: Shale pit located about 0.65 mile (1.05 km) northeast of the church in Martha Furnace.

LATITUDE: 40°50'20"N

LONGITUDE: 78°00'09"W

GEOLOGIC UNIT: Hamilton Group, Devonian

DESCRIPTION: Dark-gray (N3), very thin bedded shale occurs stratigraphically below the shale collected in sample 95-0-1A. The shale breaks to form platy to flaggy fragments. Light- to moderate-brown (5YR5/6 to 5YR4/4) iron staining is common along fractures and bedding planes. Sample 95-0-1B was collected stratigraphically below sample 95-0-1A.

ATTITUDE OF BEDDING: N45E, 26NW

WEATHERING INTENSITY: Slight

SAMPLED INTERVAL: Composite sample representing 25 feet (8 m) of stratigraphic section

CHEMICAL ANALYSIS:

	%
SiO ₂	65.1
Al ₂ O ₃	15.70
Σ"Fe ₂ O ₃ ".....	5.75
MgO.....	1.39
CaO.....	0.03
Na ₂ O.....	0.64
K ₂ O.....	3.68
TiO ₂	0.88
MnO.....	0.025
Total	93.20

MINERALOGY (X-RAY):

	Weight %
Quartz	28
Mica-smectite	67
Kaolinite	0
Chlorite-vermiculite	2
Feldspar	3
Calcite	0

RAW PROPERTIES:

Water of plasticity (%):	17.6
Drying shrinkage (%):	2.5
Workability:	Short
Dry strength:	Fair
pH:	4.8

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (5YR7/6)	3	5.0	13.7	26.4	1.92
1900						
1050	Brownish orange (2.5YR5/8)	4	5.0	9.5	19.5	2.06
2000						
1100	Strong brown (2.5YR4/6)	6	5.0	6.8	14.4	2.12
2100						
1150	---	---	Melted	---	---	---
2200						
1200	---	---	---	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: ND

BLOATING TEST: Positive

REMARKS: Abrupt vitrification (1100-1150°C).

BLOATING TEST (QUICK-FIRING):

Temp. (°F) (°C)	Bulk density (g/cc) (lb/ft ³)		% Absorb.	Remarks
1800 1000	--	--	--	--
1900 1050	2.13	133.0	6.1	No expansion.
2000 1100	1.84	114.9	9.7	Slight expansion.
2100 1150	1.39	86.8	17.5	Partial expansion.
2200 1200	0.92	57.4	19.5	Overfired.
2300 1250	--	--	--	--

REMARKS: Too heavy for lightweight aggregate.

POTENTIAL USES: Facing brick at 1050°C.

CENTRE COUNTY

WORTH TOWNSHIP

PORT MATILDA QUADRANGLE

SAMPLE NUMBER 95-D-2

LOCATIONID: Shale pit located on the southwest side of U. S. Route 322, about D.4 mile (64D m) northwest of Port Matilda.

LATITUDE: 4D°48'D8"N

LONGITUDE: 78°D3'38"W

GEOLOGIC UNIT: Fisher Ridge Member, Mahantango Formation, Devonian

DESCRIPTION: Interbedded very thin bedded shale and thin-bedded shaly siltstone are exposed in this pit, which is about 15D feet (46 m) long and 20 to 30 feet (6 to 9 m) high. Beds are predominantly dark gray (N4) to medium light gray (N6). The shale breaks to form platy fragments, whereas the shaly siltstone breaks into slabby fragments. The sample was collected near the north end of the pit.

ATTITUDE OF BEDDING: N35E, 24NW

WEATHERING INTENSITY: Slight

SAMPLED INTERVAL: Channel sample through 13 feet (4 m) of stratigraphic section

CHEMICAL ANALYSIS:

	%
SiO ₂	61.5
Al ₂ O ₃	17.45
Σ"Fe ₂ O ₃ ".....	7.05
MgO.....	1.78
CaO.....	D.13
Na ₂ O.....	D.74
K ₂ O.....	4.D7
TiO ₂	I.D8
MnO.....	D.D5D
Total	93.85

MINERALOGY (X-RAY):

	Weight %
Quartz	23
Mica-smectite	70
Kaolinite	0
Chlorite-vermiculite	5
Feldspar	2
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 15.8
Drying shrinkage (%): 5.0
Workability: Short
Dry strength: Fair
pH: 5.9

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
18D0 1DD0	Mod. orange (5YR6/8)	3	5.D	10.9	22.7	2.D8
19D0 105D	Strong brown (2.5YR4/8)	5	7.5	6.5	14.6	2.25
2DD0 11D0	Strong brown (2.5YR4/6)	6	7.5	4.0	9.3	2.3D
21D0 115D	Mod. reddish brown (2.5YR3/4)	7	10.0	2.0	4.7	2.33
22D0 12D0	---	---	Melted	---	---	---
2300 125D	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: ND

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Facing brick at 1D5D-11D0°C.

CENTRE COUNTY

BOGGS TOWNSHIP

BELLEFONTE QUADRANGLE

SAMPLE NUMBER 105-B-1A

LOCATION: Inactive shale quarry on the northwest side of the light-duty road that trends northeast from the southeast corner of the Trczyulny Cemetery. The distance from the cemetery to the quarry along this road is approximately 0.55 mile (880 m).

LATITUDE: 40°57'10"N

LONGITUDE: 77°47'02"W

GEOLOGIC UNIT: Harrell Shale, Devonian

DESCRIPTION: Medium-dark-gray (N4) to dark-gray (N3), noncalcareous claystone is exposed in the upper part of the quarry. The partings in the claystone are spaced from about 1/4 to 1 inch (0.6 to 3 cm) apart. The claystone commonly breaks into slabby or flaggy fragments, but also breaks into a few platy fragments. Moderate-yellow-brown (10YR5/4) to dark-yellow-orange (10YR6/6) iron stains are present along fractures and partings.

ATTITUDE OF BEDDING: N70E, 30NW

WEATHERING INTENSITY: Slight

SAMPLED INTERVAL: Representative sample of 15 feet (5 m) of stratigraphic section

CHEMICAL ANALYSIS:

	%
SiO ₂	61.0
Al ₂ O ₃	17.90
Σ"Fe ₂ O ₃ ".....	6.30
MgO.....	1.80
CaO.....	0.13
Na ₂ O.....	0.65
K ₂ O.....	4.00
TiO ₂	0.95
MnO.....	0.034
Total	92.76

MINERALOGY (X-RAY):

	Weight %
Quartz	26
Mica-smectite	68
Kaolinite	0
Chlorite-vermiculite	4
Feldspar	2
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 13.0
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Fair
 pH: 6.0

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (5YR6/8)	5	2.5	10.3	21.5	2.10
1900						
1050	Strong brown (2.5YR4/8)	7	7.5	4.5	10.5	2.33
2000						
1100	Strong brown (2.5YR4/6)	7	7.5	1.6	3.9	2.40
2100						
1150	---	---	Melted	---	---	---
2200						
1200	---	---	---	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: ND

BLOATING TEST: Negative

REMARKS: Abrupt vitrification (1000-1050°C).

POTENTIAL USES: Facing brick at 1000°C and below.

CENTRE COUNTY

BOGGS TOWNSHIP

BELLEFONTE QUADRANGLE

SAMPLE NUMBER 105-B-1B

LOCATION: Inactive shale quarry on the northwest side of the light-duty road that trends northeast from the southeast corner of the Trczyulny Cemetery. The distance from the cemetery to the quarry along the road is approximately 0.55 mile (880 m).

LATITUDE: 40°57'10"N

LONGITUDE: 77°47'02"W

GEOLOGIC UNIT: Harrell Shale, Devonian

DESCRIPTION: Predominantly dark-gray (N3), noncalcareous fissile shale occurs stratigraphically beneath sample 105-B-1A. The shale breaks into papery to platy fragments having angular edges. Dark-yellow-orange (10YR6/6) iron stains are common along fractures and bedding.

ATTITUDE OF BEDDING: N70E, 30NW

WEATHERING INTENSITY: Slight

SAMPLED INTERVAL: Representative sample of 20 feet (6 m) of stratigraphic section

CHEMICAL ANALYSIS:

	%
SiO ₂	62.0
Al ₂ O ₃	16.80
Σ"Fe ₂ O ₃ ".....	6.05
MgO.....	1.65
CaO.....	0.13
Na ₂ O.....	0.65
K ₂ O.....	3.77
TiO ₂	0.95
MnO.....	0.034
Total	92.03

MINERALOGY (X-RAY):

	Weight %
Quartz	25
Mica-smectite	67
Kaolinite	0
Chlorite-vermiculite	4
Feldspar	4
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 14.0
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Fair
 pH: 6.1

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (5YR6/8)	5	2.5	11.6	23.8	2.05
1900						
1050	Strong brown (2.5YR4/6)	6	5.0	4.4	10.3	2.33
2000						
1100	Mod. reddish brown (2.5YR4/4)	7	7.5	1.5	3.6	2.43
2100						
1150	---	---	Melted	---	---	---
2200						
1200	---	---	---	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: ND

BLOATING TEST: Negative

REMARKS: Abrupt vitrification (1000-1050°C).

POTENTIAL USES: Facing brick at 1000°C and below.

CENTRE COUNTY

BOGGS TOWNSHIP

BELLEFONTE QUADRANGLE

SAMPLE NUMBER 105-B-1C

LOCATION: Inactive shale quarry on the northwest side of the light-duty road that trends northeast from the southeast corner of the Trzcizulny Cemetery. The distance from the cemetery to the quarry is approximately 0.55 mile (880 m).

LATITUDE: 40°57'10"N

LONGITUDE: 77°47'02"W

GEOLOGIC UNIT: Harrell Shale, Devonian

DESCRIPTION: Dark-gray (N3) to brownish-black (5YR2/1) claystone and some interbeds of fissile shale occur below sample 105-B-1B. The claystone breaks into slabby to rubbly fragments, the fissile shale into papery to platy fragments. Dark-yellowish-orange (10YR6/6) to moderate-brown (5YR4/4) iron stains are common along fractures and bedding.

ATTITUDE OF BEDDING: N70E, 30NW

WEATHERING INTENSITY: Slight

SAMPLED INTERVAL: Representative sample of 20 feet (6 m) of stratigraphic section

CHEMICAL ANALYSIS:

	%
SiO ₂	62.8
Al ₂ O ₃	17.30
Σ"Fe ₂ O ₃ ".....	5.95
MgO.....	1.92
CaO.....	0.15
Na ₂ O.....	0.72
K ₂ O.....	3.85
TiO ₂	0.94
MnO.....	0.048
Total	93.68

MINERALOGY (X-RAY):

	Weight %
Quartz	25
Mica-smectite	68
Kaolinite	0
Chlorite-vermiculite	4
Feldspar	2
Calcite	1

RAW PROPERTIES:

Water of plasticity (%): 13.2
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Fair
 pH: 6.2

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Brownish orange (5YR5/8)	5	2.5	10.7	22.3	2.08
1900						
1050	Strong brown (2.5YR4/6)	6	5.0	5.6	12.8	2.28
2000						
1100	Mod. reddish brown (2.5YR4/4)	7	7.5	2.8	6.5	2.30
2100						
1150	---	---	Melted	---	---	---
2200						
1200	---	---	---	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Facing brick at <1000-1050°C.

CENTRE COUNTY

BOGGS TOWNSHIP

BELLEFONTE QUADRANGLE

SAMPLE NUMBER 105-B-1D

LOCATION: Inactive shale quarry on the northwest side of the light-duty road that trends northeast from the southeast corner of the Trczyulny Cemetery. The distance from the cemetery to the quarry is approximately 0.55 mile (880 m).

LATITUDE: 40°57'10"N

LONGITUDE: 77°47'02"W

GEOLOGIC UNIT: Hamilton Group, Devonian

DESCRIPTION: Predominantly light-olive-gray (5Y5/2) shale and some interbeds of moderate-olive-brown (5YR4/4) shale occurs directly below a thin limestone bed which probably defines the upper contact of the Hamilton Group. The shale breaks into platy to flaggy fragments. Dark-yellowish-brown (10YR6/6) to dusky-yellowish-brown (10YR2/2) iron staining is present in minor amounts along fractures and bedding.

ATTITUDE OF BEDDING: N70E, 30NW

WEATHERING INTENSITY: Moderate

SAMPLED INTERVAL: Representative sample of 15 feet (5 m) of stratigraphic section

CHEMICAL ANALYSIS:

	%
SiO ₂	61.8
Al ₂ O ₃	17.65
Σ"Fe ₂ O ₃ ".....	7.15
MgO.....	1.86
CaO.....	0.44
Na ₂ O.....	0.75
K ₂ O.....	3.57
TiO ₂	1.00
MnO.....	0.100
Total	94.32

MINERALOGY (X-RAY):

	Weight %
Quartz	28
Mica-smectite	66
Kaolinite	0
Chlorite-vermiculite	2
Feldspar	4
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 15.0
Drying shrinkage (%): 0
Workability: Short
Dry strength: Fair
pH: 7.1

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800 1000	Brownish orange (2.5YR5/8)	5	2.5	10.9	22.8	2.09
1900 1050	Strong brown (2.5YR4/6)	6	5.0	3.2	7.6	2.37
2000 1100	Mod. reddish brown (2.5YR3/4)	7	7.5	0.7	1.7	2.46
2100 1150	---	---	Melted	---	---	---
2200 1200	---	---	---	---	---	---
2300 1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Abrupt vitrification (1000-1050°C).

POTENTIAL USES: Facing brick at 1000°C and below.

CENTRE COUNTY

UNION TOWNSHIP

BELLEFONTE QUADRANGLE

SAMPLE NUMBER 105-B-2

LOCATION: Shale pit along the northwest side of U. S. Route 220, approximately 1,000 feet (300 m) northeast of Unionville.

LATITUDE: 40°54'39"N

LONGITUDE: 77°52'16"W

GEOLOGIC UNIT: Harrell Shale, Devonian

DESCRIPTION: Dark-gray (N3), thin-bedded, noncalcareous shale is exposed in the pit. The shale breaks into predominantly platy fragments. Pale-yellowish-green (10YR8/6) to dark-yellowish-orange (10YR6/6) iron staining is common along fractures and bedding planes.

ATTITUDE OF BEDDING: N50E, 43NW

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Composite representing the lower 20 feet (6 m) of stratigraphic sequence of shale

CHEMICAL ANALYSIS:

	%
SiO ₂	63.2
Al ₂ O ₃	17.25
Σ"Fe ₂ O ₃ ".....	6.60
MgO.....	1.96
CaO.....	0.40
Na ₂ O.....	0.74
K ₂ O.....	3.75
TiO ₂	0.93
MnO.....	0.038
Total	94.87

MINERALOGY (X-RAY):

	Weight %
Quartz	25
Mica-smectite	68
Kaolinite	0
Chlorite-vermiculite	4
Feldspar	3
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 11.6
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Fair
 pH: 7.0

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Brownish orange (5YR5/8)	5	2.5	11.9	24.2	2.04
1900						
1050	Strong brown (2.5YR4/6)	6	5.0	7.3	16.1	2.20
2000						
1100	Strong brown (2.5YR4/6)	7	5.0	4.8	10.8	2.26
2100						
1150	---	---	Melted	---	---	---
2200						
1200	---	---	---	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Abrupt vitrification (1100-1150°C).

POTENTIAL USES: Facing brick at 1000-1050°C.

CENTRE COUNTY

BOGGS TOWNSHIP

MINGOVILLE QUADRANGLE

SAMPLE NUMBER 115-A-1

LOCATION: Exposure along the southwest side of Interstate Route 80, about 0.45 mile (720 m) northwest of the place where Nittany Creek flows under the interstate highway.

LATITUOE: 40°57'13"N

LONGITUOE: 77°44'54"W

GEOLOGIC UNIT: Marcellus Formation, Oevonian

OESCRPTION: Brownish-black (5YR2/1) to grayish-black (N2) fissile shale is exposed for a distance of about 200 feet (60 m) along the southwest side of Interstate Route 80. The shale breaks to form papery to platy fragments which average about 0.06 inch (0.15 cm) in thickness. Weathered surfaces of the shale are iron stained and range from dark yellowish orange (10YR6/6) to moderate brown (5YR3/4) in color.

ATTITUOE OF BEOOING: N50E, 42NW

WEATHERING INTENSITY: Slight

SAMPLEO INTERVAL: Grab sample collected at uniform intervals over 100 feet (30 m) of stratigraphic section

CHEMICAL ANALYSIS:		MINERALOGY (X-RAY):	
	%		Weight %
SiO ₂	63.0	Quartz	34
Al ₂ O ₃	16.65	Mica-smectite	55
Σ"Fe ₂ O ₃ ".....	2.75	Kaolinite	10
MgO.....	0.93	Chlorite-vermiculite	0
CaO.....	0.04	Feldspar	1
Na ₂ O.....	0.13	Calcite	0
K ₂ O.....	3.58	RAW PROPERTIES:	
TiO ₂	0.79		
MnO.....	0.004		
Total	87.87		
		Water of plasticity (%): 19.4	
		Drying shrinkage (%): 2.5	
		Workability: Short	
		Dry strength: Fair	
		pH: 4.1	

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800 1000	Mod. yellowish pink (2.5YR7/6)	3	5.0	22.2	36.5	1.65
1900 1050	Mod. orange (5YR7/6)	3	5.0	18.2	31.6	1.74
2000 1100	Mod. orange (5YR7/6)	5	7.5	14.7	26.9	1.82
2100 1150	Brownish orange (2.5YR5/8)	6	10.0	10.6	20.6	1.94
2200 1200	Grayish reddish orange (2.5YR5/6)	7	10.0	5.7	11.7	2.06
2300 1250	---	---	Melted	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Abrupt vitrification (1200-1250°C).

POTENTIAL USES: Facing brick at 1100-1200°C.

INDIVIDUAL SAMPLE DATA, CENTRE COUNTY

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CENTRE COUNTY

HOWARD TOWNSHIP

MINGOVILLE QUADRANGLE

SAMPLE NUMBER 115-A-3

LOCATION: Inactive shale pit on State Park lands about 0.55 mile (880 m) north of the village of Mount Eagle and about 0.40 mile (640 m) northeast of Kennedy Church, which is near the southeast corner of the Howards State Nursery.

LATITUDE: 40°59'26"N

LONGITUDE: 77°42'15"W

GEOLOGIC UNIT: Marcellus Formation, Devonian

DESCRIPTION: Brownish-black (5YR2/1) fissile shale of the Marcellus Formation is exposed in this inactive pit. The shale breaks into papery to platy fragments, and iron staining is common along fractures and bedding planes. Sample was collected at the southern part of the exposure in the pit.

ATTITUDE OF BEDDING: N43E, 29NW

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Composite representative of 20 feet (6 m) of stratigraphic sequence of shale

CHEMICAL ANALYSIS:

MINERALOGY (X-RAY):

ANALYSES NOT DONE BECAUSE SAMPLE HAS NO POTENTIAL USES

SiO₂.....

Quartz

Al₂O₃.....

Mica-smectite

Σ"Fe₂O₃".....

Kaolinite

MgO.....

Chlorite-vermiculite

CaO.....

Feldspar

Na₂O.....

Calcite

K₂O.....

RAW PROPERTIES:

TiO₂.....

Water of plasticity (%): ---

MnO.....

Drying shrinkage (%): ---

Workability: Short

Dry strength: Fair

pH: 3.7

Total

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	---	---	No bond	---	---	---
1900						
1050	---	---	---	---	---	---
2000						
1100	---	---	---	---	---	---
2100						
1150	---	---	---	---	---	---
2200						
1200	---	---	---	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Not suitable for use in structural clay products. No bond.

CENTRE COUNTY

POTTER TOWNSHIP

CENTRE HALL QUADRANGLE

SAMPLE NUMBER 115-C-2A

LOCATION: Shale quarry operated by Roy E. Royer, who markets the raw material for use on township roads. The quarry is located on the west side of medium-duty road, about 0.30 mile (480 m) north of Sprucetown Church.

LATITUDE: 40°48'48"N

LONGITUDE: 77°37'41"W

GEOLOGIC UNIT: Reedsville Formation, Ordovician

DESCRIPTION: Medium-dark-gray (N4) to dark-gray (N3), very thin bedded shale is exposed in the northwest corner of the quarry under a 10-inch- (25-cm-) thick sandstone bed. The shale breaks into splintery fragments. Some iron staining is present along fractures and bedding planes in the shale.

ATTITUDE OF BEDDING: N50E, 26NW

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Channel sample through 14 feet (4 m) of stratigraphic section

CHEMICAL ANALYSIS:		MINERALOGY (X-RAY):	
	%		Weight %
SiO ₂	61.6	Quartz	24
Al ₂ O ₃	17.05	Mica-smectite	70
Σ"Fe ₂ O ₃ ".....	7.72	Kaolinite	0
MgO.....	2.59	Chlorite-vermiculite	2
CaO.....	0.21	Feldspar	4
Na ₂ O.....	0.93	Calcite	0
K ₂ O.....	3.75		
TiO ₂	0.95		
MnO.....	0.087		
Total	94.89		

RAW PROPERTIES:
Water of plasticity (%): 17.2
Drying shrinkage (%): 2.5
Workability: Short
Dry strength: Fair
pH: 5.7

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Brownish orange (5YR5/8)	3	5.0	10.6	22.0	2.06
1900						
1050	Strong brown (2.5YR4/8)	4	5.0	4.3	9.9	2.27
2000						
1100	Strong brown (2.5YR4/6)	5	7.5	3.2	7.2	2.28
2100	Mod. reddish brown					
1150	(2.5YR3/4)	7	7.5	2.4	5.5	2.28
2200						
1200	---	---	Melted	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Positive

REMARKS: Abrupt vitrification (1000-1050°C).

BLOATING TEST (QUICK-FIRING):

Temp. (°F) (°C)	Bulk density ³ (g/cc) (lb/ft ³)		% Absorb.	Remarks
1800 1000	2.20	137.4	6.0	No expansion.
1900 1050	1.69	105.6	7.8	Slight expansion.
2000 1100	1.31	81.8	8.4	Good pore structure.
2100 1150	0.91	56.8	5.7	Overfired.
2200 1200	--	--	--	--
2300 1250	--	--	--	--

REMARKS: Too heavy for lightweight aggregate.

POTENTIAL USES: Facing tile at 1050-1150°C.

CENTRE COUNTY

POTTER TOWNSHIP

CENTRE HALL QUADRANGLE

SAMPLE NUMBER 115-C-2B

LOCATION: Shale quarry operated by Roy E. Royer, who markets the material for use on township roads. The quarry is located on the west side of a medium-duty road, about 0.30 mile (480 m) north of Sprucetown Church.

LATITUDE: 40°48'48"N

LONGITUDE: 77°37'41"W

GEOLOGIC UNIT: Reedsville Formation, Ordovician

DESCRIPTION: Medium-dark-gray (N4) to dark-gray (N3), very thin bedded shale interbedded with a few thin siltstone beds occurs for a stratigraphic interval of 10 feet (3 m) below sample 115-C-2A. The siltstone beds range from 0.5 to 3.5 inches (1.3 to 9 cm) in thickness. Some iron staining is present along the fractures and bedding planes in these rocks. Shale breaks into splintery or platy fragments.

ATTITUDE OF BEDDING: N50E, 26NW

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Channel sample through 10 feet (3 m) of section

CHEMICAL ANALYSIS:		MINERALOGY (X-RAY):	
	%		Weight %
SiO ₂	66.5	Quartz	19
Al ₂ O ₃	18.10	Mica-smectite	72
Σ"Fe ₂ O ₃ ".....	7.70	Kaolinite	0
MgO.....	2.63	Chlorite-vermiculite	5
CaO.....	0.20	Feldspar	4
Na ₂ O.....	0.95	Calcite	0
K ₂ O.....	3.77		
TiO ₂	1.00	RAW PROPERTIES:	
MnO.....	0.090		
Total	100.94		
		Water of plasticity (%): 12.0	
		Drying shrinkage (%): 2.5	
		Workability: Short	
		Dry strength: Fair	
		pH: 5.9	

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Brownish orange (5YR5/8)	5	2.5	9.7	20.6	2.13
1900						
1050	Strong brown (2.5YR4/6)	6	5.0	4.9	11.4	2.33
2000						
1100	Strong brown (2.5YR4/6)	6	7.5	3.0	7.0	3.37
2100						
1150	---	---	Melted	---	---	---
2200						
1200	---	---	---	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Positive

REMARKS: Abrupt vitrification (1100-1150°C).

BLOATING TEST (QUICK-FIRING):

Temp. (°F) (°C)	Bulk density (g/cc) (lb/ft ³)		% Absorb.	Remarks
1800 1000	2.17	135.6	5.6	No expansion.
1900 1050	1.90	118.7	6.2	Slight expansion.
2000 1100	1.24	77.4	7.9	Good pore structure.
2100 1150	0.81	50.6	9.8	Overfired.
2200 1200	--	--	--	--
2300 1250	--	--	--	--

REMARKS: Too heavy for lightweight aggregate.

POTENTIAL USES: Facing brick at 1000-1100°C.

CENTRE COUNTY

POTTER TOWNSHIP

CENTRE HALL QUADRANGLE

SAMPLE NUMBER 115-C-2C

LOCATION: Shale quarry operated by Roy E. Royer, who markets the material for use on township roads. The quarry is located on the west side of a medium-duty road, about 0.30 mile (480 m) north of Sprucetown Church.

LATITUDE: 40°48'48"N

LONGITUDE: 77°37'41"W

GEOLOGIC UNIT: Reedsville Formation, Ordovician

DESCRIPTION: Medium-dark-gray (N4) to dark-gray (N3), very thin bedded shale and a few beds of siltstone extend stratigraphically below sample 115-C-2B. One siltstone bed is 6 inches (15 cm) thick. The shale breaks down to splintery and platy fragments. Some iron staining is present along fractures and bedding planes in the rocks.

ATTITUDE OF BEDDING: N50E, 26NW

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Channel sample through 10 feet (3 m) of section

CHEMICAL ANALYSIS:

	%
SiO ₂	59.0
Al ₂ O ₃	17.35
Σ"Fe ₂ O ₃ ".....	7.90
MgO.....	2.45
CaO.....	0.17
Na ₂ O.....	0.95
K ₂ O.....	3.80
TiO ₂	0.95
MnO.....	0.110
Total	92.68

MINERALOGY (X-RAY):

	Weight %
Quartz	22
Mica-smectite	70
Kaolinite	0
Chlorite-vermiculite	5
Feldspar	3
Calcite	0

RAW PROPERTIES:

Water of plasticity (%)	13.0
Drying shrinkage (%)	13.0
Workability:	Short
Dry strength:	Fair
pH:	6.0

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Brownish orange (5YR5/8)	5	2.5	10.4	21.9	2.10
1900						
1050	Strong brown (2.5YR4/6)	6	5.0	6.0	13.6	2.27
2000						
1100	Strong brown (2.5YR4/6)	7	7.5	3.7	8.5	2.32
2100						
1150	---	---	Melted	---	---	---
2200						
1200	---	---	---	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Positive

REMARKS: Abrupt vitrification (1100-1150°C).

BLOATING TEST (QUICK-FIRING):

Temp. (°F) (°C)	Bulk density (g/cc) (lb/ft ³)		% Absorb.	Remarks
1800 1000	2.09	130.6	8.6	No expansion.
1900 1050	1.86	116.3	7.0	Slight expansion.
2000 1100	1.43	89.3	7.5	Good pore structure.
2100 1150	0.96	60.0	8.5	Overfired; mixture.
2200 1200	--	--	--	--
2300 1250	--	--	--	--

REMARKS: Too heavy for lightweight aggregate.

POTENTIAL USES: Facing brick at 1000-1100°C.

FULTON COUNTY

TAYLOR TOWNSHIP

HUSTONVILLE QUADRANGLE

SAMPLE NUMBER 98-D-2

LOCATION: Exposure along the northeast side of Pa. Route 665 about 2.2 miles (3.5 km) northwest of Hustonville and about 600 feet (185 m) south of the place where Lick Branch to Wonder Bridge Creek crosses Pa. Route 665.

LATITUDE: 40°03'45"N

LONGITUDE: 78°03'50"W

GEOLOGIC UNIT: Catskill Formation, Devonian

DESCRIPTION: Grayish-red (10R4/2), thin-bedded shale interbedded with a few siltstone beds in the sampled interval within the exposure. Stratigraphically above this interval, numerous siltstone and sandstone beds occur. Because of this lithologic change, the sampling was restricted to the shale-siltstone sequence. The shale breaks down to form hackly to rubbly fragments, whereas the siltstone tends to form blocky fragments.

ATTITUDE OF BEDDING: N32E, 20SE

WEATHERING INTENSITY: Slight

SAMPLED INTERVAL: Channel through 12 stratigraphic feet (4 m)

CHEMICAL ANALYSIS:

	%
SiO ₂	61.2
Al ₂ O ₃	16.90
Σ"Fe ₂ O ₃ ".....	8.05
MgO.....	1.45
CaO.....	0.30
Na ₂ O.....	0.40
K ₂ O.....	4.62
TiO ₂	0.94
MnO.....	0.063
Total	93.92

MINERALOGY (X-RAY):

	Weight %
Quartz	26
Mica-smectite	71
Kaolinite	0
Chlorite-vermiculite	1
Feldspar	2
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 13.6
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Fair
 pH: 8.1

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800	Grayish reddish orange					
1000	(2.5YR6/6)	4	2.5	9.1	19.4	2.14
1900	Grayish reddish orange					
1050	(2.5YR5/6)	4	5.0	6.8	15.2	2.23
2000						
1100	Strong brown (2.5YR4/6)	5	7.5	2.6	6.3	2.36
2100						
1150	---	---	Melted	---	---	---
2200						
1200	---	---	---	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Presence of carbonates could cause problems.

POTENTIAL USES: Structural clay products (e.g., building brick, floor brick at 1000-1100°C).

FULTON COUNTY

BRUSH CREEK TOWNSHIP

BREEZEWOOD QUADRANGLE

SAMPLE NUMBER 99-A-9

LOCATION: Shale pit exposed on the east side of Pa. Route 915, about 0.20 mile (340 m) northwest of the church in the village of Akersville.

LATITUDE: 39°58'54"N

LONGITUDE: 78°12'03"W

GEOLOGIC UNIT: Mauch Chunk Formation, Mississippian

DESCRIPTION: Grayish-red (10R4/2), interbedded, thin-bedded silty shale and shaly siltstone occurs stratigraphically below a red sandstone near the southeast end of the pit. The beds range in thickness from about 1 to 4 inches (3 to 10 cm) and commonly break to form platy fragments. Joints in the rocks are closely spaced, ranging from 1 to 3 inches (3 to 9 cm) apart.

ATTITUDE OF BEDDING: N30W, 10NE

WEATHERING INTENSITY: ---

SAMPLED INTERVAL: Channel sample through 10 feet (3 m) of stratigraphic section of shale

CHEMICAL ANALYSIS:

	%
SiO ₂	64.3
Al ₂ O ₃	16.00
Σ"Fe ₂ O ₃ ".....	6.55
MgO.....	2.10
CaO.....	1.40
Na ₂ O.....	0.93
K ₂ O.....	3.32
TiO ₂	1.03
MnO.....	0.093
Total	95.72

MINERALOGY (X-RAY):

	Weight %
Quartz	28
Mica-smectite	66
Kaolinite	0
Chlorite-vermiculite	2
Feldspar	3
Calcite	1

RAW PROPERTIES:

Water of plasticity (%):	14.5
Drying shrinkage (%):	2.5
Workability:	Short
Dry strength:	Poor
pH:	8.0

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (2.5YR6/8)	3	2.5	14.5	27.5	1.75
1900						
1050	Brownish orange (2.5YR5/8)	3	2.5	13.8	24.2	1.90
2000						
1100	Strong brown (2.5YR4/6)	4	5.0	5.3	12.0	2.26
2100						
1150	Mod. reddish brown (2.5YR3/4)	6	7.5	1.9	4.5	2.35
2200						
1200	---	---	Melted	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: ND

BLOATING TEST: Negative

REMARKS: Marginal for structural clay products. Presence of carbonates could cause problems.

POTENTIAL USES: Building brick at 1100°C.

FULTON COUNTY

BETHEL TOWNSHIP

NEEDMORE QUADRANGLE

SAMPLE NUMBER 99-C-8

LOCATION: Abandoned shale pit now part of a picnic area located on the southeast side of U. S. Route 522 about 2.3 miles (3.7 km) southwest of Needmore.

LATITUDE: 39°49'15"N

LONGITUDE: 78°10'14"W

GEOLOGIC UNIT: Mahantango Formation, Devonian

DESCRIPTION: Severely weathered, thin-bedded shale is exposed in an abandoned pit which is about 20 feet (6 m) high. The shale is light brown (5YR5/6), moderate yellowish brown (10YR5/4), and pinkish gray (5YR8/1), and breaks easily into platy fragments. Joints are closely spaced; intervals are usually about 2 to 3 inches (5 to 8 cm).

ATTITUDE OF BEDDING: N40E, 83NW

WEATHERING INTENSITY: Severe

SAMPLED INTERVAL: Composite representing entire stratigraphic sequence in pit

CHEMICAL ANALYSIS:

MINERALOGY (X-RAY):

	%
SiO ₂	59.4
Al ₂ O ₃	19.75
Σ"Fe ₂ O ₃ ".....	7.10
MgO.....	0.77
CaO.....	0.02
Na ₂ O.....	0.25
K ₂ O.....	4.35
TiO ₂	1.11
MnO.....	0.008
Total	92.76

	Weight %
Quartz	17
Mica-smectite	80
Kaolinite	0
Chlorite-vermiculite	1
Feldspar	2
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 21.0
 Drying shrinkage (%): 0.0
 Workability: Short
 Dry strength: Fair
 pH: 6.6

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800	Light to mod. yellowish					
1000	pink (5YR8/4)	3	5.0	20.1	35.4	1.76
1900	Light to mod. yellowish					
1050	pink (5YR8/4)	3	5.0	17.6	32.3	1.83
2000	Grayish reddish orange					
1100	(2.5YR6/6)	5	7.5	7.9	17.2	2.16
2100	Grayish reddish orange					
1150	(2.5YR6/6)	6	7.5	5.8	12.7	2.20
2200	Grayish reddish orange					
1200	(2.5YR5/6)	7	10.0	2.6	6.1	2.34
2300						
1250	---	---	Melted	---	---	---

PYROMETRIC CONE EQUIVALENT: ND

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Building and floor brick at 1100-1200°C.

FULTON COUNTY

BETHEL TOWNSHIP

NEEDMORE QUADRANGLE

SAMPLE NUMBER 99-C-10A

LOCATION: Road exposure on the north side of the light-duty road about 200 feet (62 m) east of the Interstate Route 70 overpass located about 1.2 miles (2 km) northwest of the Warfordsburg interchange on Interstate Route 70.

LATITUDE: 39°46'35"N

LONGITUDE: 78°11'59"W

GEOLOGIC UNIT: Mahantango Formation, Devonian

DESCRIPTION: Medium-dark-gray (N4) to dark-gray (N3) silty claystone interbedded with a few beds of silty shale occurs in this exposure. A few siderite nodules are scattered throughout the lower 50 feet (15 m) of this section. Calcite veinlets, ranging from 0.25 to 0.50 inch (0.6 to 1.3 cm) in thickness, are common. The upper part of the exposure to the southeast contains a few brachiopods and other marine fossils.

ATTITUDE OF BEDDING: N20E, 86SE

WEATHERING INTENSITY: Negligible to slight

SAMPLED INTERVAL: Grab sample through 150 stratigraphic feet (45 m) of section

CHEMICAL ANALYSIS:

	%
SiO ₂	68.2
Al ₂ O ₃	15.85
Σ"Fe ₂ O ₃ ".....	6.30
MgO.....	1.78
CaO.....	0.53
Na ₂ O.....	1.15
K ₂ O.....	3.28
TiO ₂	1.14
MnO.....	0.038
Total	98.27

MINERALOGY (X-RAY):

	Weight %
Quartz	30
Mica-smectite	60
Kaolinite	0
Chlorite-vermiculite	5
Feldspar	5
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 15.2
 Drying shrinkage (%): 5.0
 Workability: Short
 Dry strength: Poor
 pH: 8.1

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800 1000	Mod. yellowish pink to mod. orange (5YR7/6)	3	5.0	13.0	25.6	1.96
1900 1050	Mod. orange (2.5YR6/8)	3	5.0	13.0	25.4	1.97
2000 1100	Light brown to brownish orange (2.5YR5/6)	4	5.0	5.9	12.9	2.19
2100 1150	Strong brown (2.5YR4/6)	5	5.0	4.2	9.2	2.12
2200 1200	Mod. brown (2.5YR3/4)	6	5.0	3.1	6.7	2.20
2300 1250	---	---	Expanded	---	---	---

PYROMETRIC CONE EQUIVALENT: ND

BLOATING TEST: Positive

REMARKS: Presence of carbonates could cause problems.

BLOATING TEST (QUICK-FIRING):

Temp. (°F) (°C)	Bulk density ³ (g/cc) (lb/ft ³)		% Absorb.	Remarks
1800 1000	--	--	--	--
1900 1050	13.6	128.9	8.1	Slight expansion.
2000 1100	11.2	102.5	6.8	Slight expansion.
2100 1150	9.4	94.3	6.5	Good pore structure.
2200 1200	7.1	54.8	6.2	Some large pores.
2300 1250	--	--	--	--

REMARKS: Marginal lightweight aggregate (short firing range).

POTENTIAL USES: Building brick at 1100-1200°C. Marginal lightweight aggregate.

FULTON COUNTY

BETHEL TOWNSHIP

NEEDMORE QUADRANGLE

SAMPLE NUMBER 99-C-10B

LOCATION: Road exposure on the north side of the light-duty road about 200 feet (60 m) east of the Interstate Route 70 overpass located about 1.2 miles (2 km) northwest of the Warfordsburg interchange on Interstate Route 70.

LATITUDE: 39°46'35"N

LONGITUDE: 78°11'59"W

GEOLOGIC UNIT: Marcellus Formation, Devonian

DESCRIPTION: Dark-gray, fissile, carbonaceous shale of the Marcellus Formation occurs stratigraphically beneath claystone collected in sample 99-C-10B. The fissile shale breaks to form papery to platy fragments. Iron staining is common along fractures and bedding planes. Joint spacing ranges from 1 to 5 inches (3 to 13 cm). About 60 feet (18 m) of stratigraphic section of Marcellus shale is exposed at this site.

ATTITUDE OF BEDDING: N20E, 86SE

WEATHERING INTENSITY: Moderate

SAMPLED INTERVAL: Composite representative of 21 feet (6 m) of stratigraphic section of Marcellus shale

CHEMICAL ANALYSIS:

	%
SiO ₂	65.1
Al ₂ O ₃	16.65
Σ"Fe ₂ O ₃ ".....	6.00
MgO.....	1.71
CaO.....	0.18
Na ₂ O.....	0.98
K ₂ O.....	3.62
TiO ₂	1.05
MnO.....	0.033
Total	95.32

MINERALOGY (X-RAY):

	Weight %
Quartz	31
Mica-smectite	59
Kaolinite	0
Chlorite-vermiculite	5
Feldspar	5
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 14.1
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Poor
 pH: 7.5

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (5YR6/8)	3	2.5	12.8	25.7	2.00
1900						
1050	Mod. orange (5YR6/8)	3	2.5	12.3	24.7	2.01
2000	Light brown to brownish orange (2.5YR5/6)	5	5.0	6.5	14.4	2.20
2100						
1150	Strong brown (2.5YR4/6)	5	5.0	4.5	10.0	2.20
2200						
1200	Mod. brown (2.5YR3/4)	6	5.0	3.5	7.8	2.24
2300						
1250	---	---	Expanded	---	---	---

PYROMETRIC CONE EQUIVALENT: ND

BLOATING TEST: Positive

REMARKS: ---

BLOATING TEST (QUICK-FIRING):

Temp. (°F) (°C)	Bulk density (g/cc) (lb/ft ³)		% Absorb.	Remarks
1800 1000	--	--	--	--
1900 1050	1.98	123.5	8.8	Slight expansion.
2000 1100	1.60	99.5	7.5	Good pore structure.
2100 1150	1.41	88.2	6.8	Good pore structure.
2200 1200	0.98	60.9	6.5	Some large pores (sticky).
2300 1250	--	--	--	--

REMARKS: Marginal for lightweight aggregate (heavy).

POTENTIAL USES: Building and floor brick at 1100-1200°C.

FULTON COUNTY

AYR TOWNSHIP

BIG COVE TANNERY QUADRANGLE

SAMPLE NUMBER 99-D-7

LOCATION: Exposure along the northwest side of U. S. Route 522, about 0.2 mile (310 m) northeast of the bridge over Big Cove Creek.

LATITUDE: 39°51'28"N

LONGITUDE: 78°02'32"W

GEOLOGIC UNIT: Mahantango Formation, Devonian

DESCRIPTION: Olive-gray (5Y4/1), thin-bedded shale occurs stratigraphically above a 31-inch- (80-cm-) thick sandstone bed near the east end of this exposure. The shale breaks to form platy fragments. Spacing of a major, well-defined joint set, which strikes N75E and has a dip of 63S, ranges from about 8 to 12 inches (20 to 30 cm).

ATTITUDE OF BEDDING: N20E, 85NW

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Composite representative of 20 feet (6 m) of stratigraphic section

CHEMICAL ANALYSIS:

	%
SiO ₂	67.7
Al ₂ O ₃	15.10
Σ"Fe ₂ O ₃ ".....	6.30
MgO.....	1.50
CaO.....	0.31
Na ₂ O.....	1.00
K ₂ O.....	3.10
TiO ₂	1.09
MnO.....	0.038
Total	96.14

MINERALOGY (X-RAY):

	Weight %
Quartz	28
Mica-smectite	50
Kaolinite	17
Chlorite-vermiculite	1
Feldspar	4
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 16.3
 Drying shrinkage (%): 5.0
 Workability: Short
 Dry strength: Poor
 pH: 7.7

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800 1000	Mod. to strong orange (2.5YR6/10)	3	5.0	13.7	26.9	1.96
1900 1050	Mod. orange (2.5YR6/8)	3	5.0	13.0	25.6	1.97
2000 1100	Strong brown (2.5YR4/8)	4	7.5	6.0	13.3	2.23
2100 1150	Strong brown (2.5YR4/6)	4	7.5	3.6	8.1	2.28
2200 1200	Mod. reddish brown (2.5YR3/4)	5	7.5	2.2	5.1	2.34
2300 1250	---	---	Melted	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Building and floor brick at 1100-1200°C.

FULTON COUNTY

DUBLIN TOWNSHIP

BURNT CABINS QUADRANGLE

SAMPLE NUMBER 108-C-15

LOCATION: Abandoned quarry located about 0.4 mile (610 m) north of Fort Littleton.

LATITUDE: 40°04'05"N

LONGITUDE: 77°57'51"W

GEOLOGIC UNIT: Clinton Group, Silurian

DESCRIPTION: Light-olive-brown (5Y5/6), very thin to thin-bedded and interbedded shale and silty shale are exposed in this quarry. The beds range in thickness from less than 1 inch (3 cm) up to about 3 inches (8 cm). The shale and silty shale break to form platy to flaggy fragments. A few siltstone beds also occur in this sequence. They break to form blocky fragments. Iron and manganese staining occur in moderate amounts along fractures and bedding planes.

ATTITUDE OF BEDDING: N20W, 1BSW

WEATHERING INTENSITY: Moderate

SAMPLED INTERVAL: Composite representing 20 stratigraphic feet (6 m) at top of quarry

CHEMICAL ANALYSIS:		MINERALOGY (X-RAY):	
	%		Weight %
SiO ₂	61.3	Quartz	26
Al ₂ O ₃	18.70	Mica-smectite	70
Σ"Fe ₂ O ₃ ".....	6.65	Kaolinite	0
MgO.....	1.40	Chlorite-vermiculite	2
CaO.....	0.17	Feldspar	2
Na ₂ O.....	0.24	Calcite	0
K ₂ O.....	4.56		
TiO ₂	0.95		
MnO.....	0.065		
Total	94.04		

RAW PROPERTIES:
Water of plasticity (%): 14.8
Drying shrinkage (%): 2.5
Workability: Short
Dry strength: Fair
pH: 8.0

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (2.5YR6/8)	3	2.5	10.8	22.3	2.06
1900						
1050	Brownish orange (2.5YR5/8)	4	5.0	7.3	16.0	2.19
2000						
1100	Strong brown (2.5YR4/6)	5	7.5	3.1	7.4	2.36
2100						
1150	---	---	Melted	---	---	---
2200						
1200	---	---	---	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Structural clay products (e.g., building brick at 1050-1100°C).

FULTON COUNTY

DUBLIN TOWNSHIP

BURNT CABINS QUADRANGLE

SAMPLE NUMBER 108-C-16

LOCATION: Abandoned quarry about 0.4 mile (610 m) north of Fort Littleton.

LATITUDE: 40°04'05"N

LONGITUDE: 77°57'51"W

GEOLOGIC UNIT: Clinton Group, Silurian

DESCRIPTION: Light-olive-brown (5Y5/6), interbedded, very thin to thin-bedded shale, silty shale, and siltstone are exposed stratigraphically below sample 108-C-15 in this quarry. The beds of shale and silty shale range in thickness from less than 1 inch (3 cm) up to about 3 inches (8 cm). The siltstone beds reach a maximum of 12 inches (31 cm), but are rare in occurrence in this sequence. The shale and silty shale break to form platy to flaggy fragments. The siltstone breaks into blocky fragments. A moderate amount of iron and manganese staining is present along the fractures and bedding planes.

ATTITUDE OF BEDDING: N20W, 18SE

WEATHERING INTENSITY: Moderate

SAMPLED INTERVAL: Composite representing 15 stratigraphic feet (5 m)

CHEMICAL ANALYSIS:

	%
SiO ₂	56.8
Al ₂ O ₃	19.95
Σ"Fe ₂ O ₃ ".....	7.00
MgO.....	1.77
CaO.....	0.19
Na ₂ O.....	0.25
K ₂ O.....	4.91
TiO ₂	0.97
MnO.....	0.066
Total	91.91

MINERALOGY (X-RAY):

	Weight %
Quartz	19
Mica-smectite	64
Kaolinite	15
Chlorite-vermiculite	1
Feldspar	1
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 15.7
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Fair
 pH: 8.1

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (2.5YR6/8)	3	2.5	10.1	21.0	2.07
1900						
1050	Brownish orange (2.5YR5/8)	4	5.0	7.1	15.6	2.19
2000						
1100	Strong brown (2.5YR4/6)	5	7.5	3.5	8.2	2.33
2100						
1150	---	---	Melted	---	---	---
2200						
1200	---	---	---	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Structural clay products (e.g., building brick at 1050-1100°C).

BURNT CABINS QUADRANGLE

LONGITUDE: 77°59'14"W

SAMPLED INTERVAL: Channel through 22 stratigraphic feet (7 m)

MINERALOGY (X-RAY):

	%		Weight %
SiO ₂	65.7	Quartz	33
Al ₂ O ₃	17.85	Mica-smectite	57
Σ"Fe ₂ O ₃ ".....	7.35	Kaolinite	2
MgO.....	1.56	Chlorite-vermiculite	5
CaO.....	0.18	Feldspar	3
Na ₂ O.....	0.47	Calcite	0
K ₂ O.....	3.59		
TiO ₂	1.05		
MnO.....	0.050		
Total	97.80		

RAW PROPERTIES:	
Water of plasticity (%):	14.6
Drying shrinkage (%):	2.5
Workability:	Short
Ory strength:	Fair
pH:	7.8

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800 1000	Strong orange (2.5YR6/10)	3	2.5	11.7	23.6	2.01
1900 1050	Deep orange (2.5YR5/10)	4	5.0	9.3	19.9	2.13
2000 1100	Strong brown (2.5YR4/8)	4	7.5	4.6	10.5	2.30
2100 1150	Strong brown (2.5YR4/6)	5	7.5	1.7	4.1	2.39
2200 1200	---	---	---	---	---	---
2300 1250	---	---	---	---	---	---

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Structural clay products (e.g., building brick at 1050-1150°C).

FULTON COUNTY

DUBLIN TOWNSHIP

BURNT CABINS QUADRANGLE

SAMPLE NUMBER 108-C-18

LOCATION: Road exposure east of a small pit along the north side of the road that connects the villages of Clear Ridge and Fort Littleton. This exposure is approximately 1 mile (1.6 km) by road southeast of Clear Ridge.

LATITUDE: 40°04'44"N

LONGITUDE: 77°59'14"W

GEOLOGIC UNIT: Devonian marine units

DESCRIPTION: Grayish-olive (10Y4/2) to moderate-olive-brown (5Y4/4), interbedded, very thin to medium-bedded shale, silty shale, and shaly siltstone occur stratigraphically below sample 108-C-17. The beds range in thickness from less than 1 inch (3 cm) up to about 6 inches (15 cm). The shale and silty shale break to form platy to flaggy fragments, whereas the siltstone breaks into rough, blocky fragments. Iron staining is common along fractures and bedding planes.

ATTITUDE OF BEDDING: N18E, 44NW

WEATHERING INTENSITY: Moderate to severe

SAMPLED INTERVAL: Channel through 10 stratigraphic feet (3 m) of section

CHEMICAL ANALYSIS:

	%
SiO ₂	64.1
Al ₂ O ₃	16.45
Σ"Fe ₂ O ₃ ".....	6.70
MgO.....	1.64
CaO.....	0.17
Na ₂ O.....	0.62
K ₂ O.....	3.34
TiO ₂	0.95
MnO.....	0.072
Total	94.04

MINERALOGY (X-RAY):

	Weight %
Quartz	37
Mica-smectite	52
Kaolinite	0
Chlorite-vermiculite	8
Feldspar	3
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 16.1
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Fair
 pH: 8.1

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (2.5YR6/8)	3	2.5	14.7	28.4	1.93
1900						
1050	Brownish orange (2.5YR5/8)	4	5.0	11.6	23.6	2.03
2000						
1100	Strong brown (2.5YR4/8)	4	5.0	6.8	15.0	2.19
2100						
1150	Strong brown (2.5YR4/6)	4	5.0	3.2	7.4	2.31
2200						
1200	---	---	Melted	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Structural clay products (e.g., building brick at 1050-1150°C).

FULTON COUNTY

TODD TOWNSHIP

McCONNELLSBURG QUADRANGLE

SAMPLE NUMBER 109-A-16

LOCATION: Exposure along the northeast side of U. S. Route 30 bypass, about 1.3 miles (2.1 km) east of the U. S. Route 30 overpass to U. S. Route 522.

LATITUDE: 39°56'41"N

LONGITUDE: 77°58'14"W

GEOLOGIC UNIT: Reedsville Formation, Ordovician

DESCRIPTION: Medium- to dark-gray (N5 to N3), thin- to medium-bedded, silty shale occurs in this exposure. Bedding is well developed, the beds ranging in thickness from 1 to 6 inches (3 to 15 cm). Joints are tight and spaced from 1 to 6 inches (3 to 15 cm) apart. The silty shale breaks to form predominantly splintery to platy fragments; a few slabby fragments are present. Locally, calcite veinlets in joints and a few siderite nodules are scattered throughout this part of the stratigraphic section.

ATTITUDE OF BEDDING: N10W, 7NE

WEATHERING INTENSITY: Negligible to slight

SAMPLED INTERVAL: Composite representative of about 20 feet (6 m) of stratigraphic section

CHEMICAL ANALYSIS:

	%
SiO ₂	60.9
Al ₂ O ₃	15.70
Σ"Fe ₂ O ₃ ".....	7.43
MgO.....	3.20
CaO.....	2.09
Na ₂ O.....	1.12
K ₂ O.....	3.46
TiO ₂	0.90
MnO.....	0.092
Total	94.89

MINERALOGY (X-RAY):

	Weight %
Quartz	24
Mica-smectite	63
Kaolinite	0
Chlorite-vermiculite	8
Feldspar	4
Calcite	1

RAW PROPERTIES:

Water of plasticity (%):	14.2
Drying shrinkage (%):	2.5
Workability:	Short
Dry strength:	Poor
pH:	8.6

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800	Mod. yellowish pink to					
1000	mod. orange (5YR7/6)	3	2.5	13.1	25.7	1.96
1900						
1050	Mod. orange (2.5YR6/8)	3	5.0	12.4	24.3	1.97
2000						
1100	Mod. reddish brown (2.5YR4/4)	5	5.0	5.0	10.3	3.08
2100						
1150	---	---	Expanded	---	---	---
2200						
1200	---	---	---	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Positive

REMARKS: Not suitable for structural clay products (abrupt vitrification between 1100 and 1150°C).

BLOATING TEST (QUICK-FIRING):

Temp. (°F) (°C)	Bulk density ³ (g/cc) (lb/ft)		% Absorb.	Remarks
1800 1000	1.83	113.9	14.6	Slight expansion.
1900 1050	1.35	84.4	11.0	Good pore structure.
2000 1100	1.25	77.7	8.4	Good pore structure.
2100 1150	0.65	40.2	7.3	Some large pores.
2200 1200	--	--	--	--
2300 1250	--	--	--	--

REMARKS: Marginal for lightweight aggregate (short firing range). Presence of carbonates could cause problems.

POTENTIAL USES: Marginal lightweight-aggregate material.

HUNTINGDON COUNTY

FRANKLIN TOWNSHIP

TYRONE QUADRANGLE

SAMPLE NUMBER 96-A-2

LOCATION: Abandoned pit known as the Critchfield manganese deposit located about 3 miles (5 km) northeast of the village of Shoenberger.

LATITUDE: 40°39'35"N

LONGITUDE: 78°08'30"W

GEOLOGIC UNIT: Gatesburg Formation, Cambrian

DESCRIPTION: White plastic clay occurs locally in some of the waste piles on the southeast edges of the pit. Former records indicate that the Critchfield Clay and Feldspar Company worked this pit for clay in the early 1940's. The amount of white clay in waste piles represents a small tonnage. Drilling by the U. S. Bureau of Mines penetrated essentially "yellow clays" according to their logs.

ATTITUDE OF BEDDING: ---

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Grab sample of white clays in waste piles

CHEMICAL ANALYSIS:

	%
SiO ₂	68.3
Al ₂ O ₃	19.90
Σ"Fe ₂ O ₃ ".....	0.95
MgO.....	0.47
CaO.....	0.02
Na ₂ O.....	0.04
K ₂ O.....	0.97
TiO ₂	0.87
MnO.....	0.022
Total	91.54

MINERALOGY (X-RAY):

	Weight %
Quartz	32
Mica-smectite	3
Kaolinite	65
Chlorite-vermiculite	0
Feldspar	0
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 29.1
 Drying shrinkage (%): 5.0
 Workability: Plastic
 Dry strength: Good
 pH: 5.4

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800	Pale yellowish pink					
1000	(5YR9/2)	3	2.5	27.5	43.2	1.57
1900	Pale yellowish pink					
1050	(5YR9/2)	3	5.0	27.3	42.9	1.57
2000	White (5YR9/1)	3	5.0	25.8	41.7	1.61
2100	White (5YR9/1)	3	5.0	24.7	40.5	1.64
2200	White (5YR9/1)	3	10.0	19.0	34.2	1.79
2300	Yellowish white					
1250	(10YR9/2)	4	12.5	10.8	22.5	2.09

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Slightly high shrinkage.

POTENTIAL USES: Structural clay products (e.g., structural tile, sanitaryware at 1250°C).

HUNTINGDON COUNTY

UNION TOWNSHIP

MOUNT UNION QUADRANGLE

SAMPLE NUMBER 107-A-2A

LOCATION: Exposure along the south side of an access road to a quarry formerly operated by the Pennsylvania Glass Sand Corporation along Sand Ridge south-southwest of Mapleton.

LATITUDE: 40°20'40"N

LONGITUDE: 77°57'15"W

GEOLOGIC UNIT: Marcellus Formation, Devonian

DESCRIPTION: Grayish-black (N2) to black (N1), fissile shale predominates in this sampled interval, although thin beds of shaly siltstone ranging from 1 to 2.5 inches (3 to 6 cm) occur from 86 to 102 inches (2.2 to 2.6 m) below the upper contact. The upper contact is defined by the change from siltstone to shale about 15 feet (5 m) east of the western limit of the exposure on the south side of the access road. Siderite nodules occur in a few places near the bottom of this sample.

ATTITUDE OF BEDDING: N18E, 75NW

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Channel through 12 feet (4 m) of stratigraphic section

CHEMICAL ANALYSIS:

	%
SiO ₂	60.7
Al ₂ O ₃	16.95
Σ"Fe ₂ O ₃ ".....	6.50
MgO.....	1.05
CaO.....	0.09
Na ₂ O.....	0.72
K ₂ O.....	3.48
TiO ₂	0.94
MnO.....	0.018
Total	90.45

MINERALOGY (X-RAY):

	Weight %
Quartz	24
Mica-smectite	63
Kaolinite	6
Chlorite-vermiculite	5
Feldspar	2
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 17.3
 Drying shrinkage (%): 2.5
 Workability: Plastic
 Dry strength: Fair
 pH: 4.1

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (5YR7/6)	3	2.5	16.2	30.7	1.90
1900						
1050	Mod. orange (5YR7/8)	4	5.0	14.0	27.5	1.97
2000	Grayish reddish orange (2.5YR5/6)	5	7.5	7.2	16.1	2.23
1100						
2100						
1150	Strong brown (2.5YR4/6)	5	10.0	3.3	7.8	2.35
2200						
1200	---	---	Melted	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Structural clay products (e.g., building brick at 1050-1150°C).

HUNTINGDON COUNTY

UNION TOWNSHIP

MOUNT UNION QUADRANGLE

SAMPLE NUMBER 107-A-2B

LOCATION: Exposure along the south side of an access road to a quarry formerly operated by the Pennsylvania Glass Sand Company along Sand Ridge south-southwest of Mapleton.

LATITUDE: 40°22'40"N

LONGITUDE: 77°57'15"W

GEOLOGIC UNIT: Marcellus Formation, Devonian

DESCRIPTION: Dark-gray (N2) to black (N1), fissile to platy shale occurs stratigraphically below sample 107-A-2A. Dark-yellowish-orange (10YR6/6) to moderate-brown (5YR4/4) iron staining is common along fractures and bedding planes. The shale breaks to form papery to platy fragments.

ATTITUDE OF BEDDING: N18E, 75NW

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Channel through 8 feet (2.4 m) of stratigraphic section

CHEMICAL ANALYSIS:

MINERALOGY (X-RAY):

	%
SiO ₂	57.6
Al ₂ O ₃	17.25
Σ"Fe ₂ O ₃ ".....	6.45
MgO.....	1.31
CaO.....	0.08
Na ₂ O.....	0.63
K ₂ O.....	4.02
TiO ₂	0.95
MnO.....	0.023
Total	88.31

	Weight %
Quartz	18
Mica-smectite	71
Kaolinite	4
Chlorite-vermiculite	5
Feldspar	2
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 26.2
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Fair
 pH: 4.0

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (5YR6/8)	3	2.5	16.0	30.3	1.89
1900						
1050	Brownish orange (5YR5/6)	3	5.0	13.5	26.7	1.97
2000						
1100	Grayish reddish orange (2.5YR5/6)	4	7.5	7.4	16.1	2.19
2100						
1150	Strong brown (2.5YR4/6)	5	10.0	3.0	6.8	2.26
2200						
1200	---	---	Melted	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: ND

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Structural clay products (e.g., building brick at 1100-1150°C).

HUNTINGDON COUNTY

UNION TOWNSHIP

MOUNT UNION QUADRANGLE

SAMPLE NUMBER 107-A-2C

LOCATION: Exposure along the south side of an access road to a quarry formerly operated by the Pennsylvania Glass Sand Corporation along Sand Ridge south-southwest of Mapleton.

LATITUDE: 40°22'40"N

LONGITUDE: 77°57'15"W

GEOLOGIC UNIT: Marcellus Formation, Devonian

DESCRIPTION: Grayish-black (N2) to black (N1), fissile to platy shale occurs below sample 107-A-2B for a stratigraphic interval of 12 feet (4 m). Iron stains are common along joints and bedding planes. The shale breaks to form papery to platy fragments.

ATTITUDE OF BEDDING: N18E, 75NW

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Channel through 12 feet (4 m) of stratigraphic section

CHEMICAL ANALYSIS:

	%
SiO ₂	60.0
Al ₂ O ₃	16.30
Σ"Fe ₂ O ₃ ".....	6.70
MgO.....	1.37
CaO.....	0.12
Na ₂ O.....	0.65
K ₂ O.....	3.65
TiO ₂	0.85
MnO.....	0.022
Total	89.66

MINERALOGY (X-RAY):

	Weight %
Quartz	22
Mica-smectite	73
Kaolinite	0
Chlorite-vermiculite	4
Feldspar	1
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 12.6
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Poor
 pH: 3.9

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (5YR7/8)	3	2.5	16.0	30.3	1.89
1900						
1050	Mod. orange (5YR7/6)	3	2.5	12.8	27.1	1.96
2000						
1100	Grayish reddish orange (2.5YR5/6)	4	5.0	8.2	17.6	2.12
2100						
1150	Strong brown (2.5YR4/6)	5	5.0	5.1	10.9	2.15
2200						
1200	---	---	Melted	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Structural clay products (e.g., building brick at 1100-1150°C).

HUNTINGDON COUNTY

UNION TOWNSHIP

MOUNT UNION QUADRANGLE

SAMPLE NUMBER 107-A-2D

LOCATION: Exposure along the south side of an access road to a quarry formerly operated by the Pennsylvania Glass Sand Corporation along Sand Ridge south-southwest of Mapleton.

LATITUDE: 40°22'40"N

LONGITUDE: 77°57'14"W

GEOLOGIC UNIT: Marcellus Formation, Devonian

DESCRIPTION: Grayish-black (N2) to black (N1), fissile to platy shale occurs below sample 107-A-2C for a stratigraphic interval of 15 feet (5 m). Dark-yellowish-orange (10YR6/6) to moderate-brown (5YR4/4) iron staining is common along joints and bedding planes. The shale breaks to form papery to platy fragments.

ATTITUDE OF BEDDING: N18E, 75NW

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Channel through 15 feet (5 m) of stratigraphic section

CHEMICAL ANALYSIS:

	%
SiO ₂	60.1
Al ₂ O ₃	17.45
Σ"Fe ₂ O ₃ ".....	7.20
MgO.....	1.43
CaO.....	0.28
Na ₂ O.....	0.64
K ₂ O.....	3.65
TiO ₂	0.85
MnO.....	0.027
Total	91.63

MINERALOGY (X-RAY):

	Weight %
Quartz	21
Mica-smectite	71
Kaolinite	3
Chlorite-vermiculite	3
Feldspar	2
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 16.9
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Poor
 pH: 4.5

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (5YR7/6)	3	2.5	17.8	32.3	1.81
1900						
1050	Mod. orange (5YR7/8)	3	2.5	16.5	30.1	1.82
2000	Grayish reddish orange (2.5YR5/6)	4	5.0	14.8	28.2	1.90
1100						
2100	Strong brown (2.5YR4/6)	5	7.5	6.0	12.5	2.09
1150						
2200						
1200	---	---	Melted	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Marginal for structural clay products (e.g., building brick at 1100°C).
 Short firing range. Abrupt vitrification between 1100 and 1150°C.

HUNTINGDON COUNTY

UNION TOWNSHIP

MOUNT UNION QUADRANGLE

SAMPLE NUMBER 107-A-2E

LOCATION: Exposure along the south side of an access road to a quarry formerly operated by the Pennsylvania Glass Sand Corporation along Sand Ridge south-southwest of Mapleton.

LATITUDE: 40°22'40"N

LONGITUDE: 77°57'14"W

GEOLOGIC UNIT: Marcellus Formation, Devonian

DESCRIPTION: Grayish-black (N2) to black (N1), fissile to platy shale occurs below sample 107-A-20 for a stratigraphic interval of 12 feet (4 m). Dark-yellowish-orange (10YR6/6) to moderate-brown (5YR4/4) iron staining is common along joints and bedding planes. The shale breaks to form papery to platy fragments.

ATTITUDE OF BEDDING: N18E, 75NW

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Channel through 12 feet (4 m) of stratigraphic section

CHEMICAL ANALYSIS:

	%
SiO ₂	57.2
Al ₂ O ₃	16.30
Σ"Fe ₂ O ₃ ".....	7.20
MgO.....	1.45
CaO.....	0.10
Na ₂ O.....	0.75
K ₂ O.....	2.65
TiO ₂	0.92
MnO.....	0.023
Total	86.59

MINERALOGY (X-RAY):

	Weight %
Quartz	20
Mica-smectite	73
Kaolinite	0
Chlorite-vermiculite	5
Feldspar	2
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 15.8
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Poor
 pH: 4.0

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (5YR7/8)	3	2.5	17.0	31.5	1.85
1900						
1050	Mod. orange (5YR7/6)	3	2.5	13.6	26.9	1.97
2000	Grayish reddish orange (2.5YR5/6)	4	5.0	8.0	17.3	2.16
1100						
2100						
1150	Strong brown (2.5YR4/6)	5	5.0	4.1	9.0	2.20
2200						
1200	---	---	Melted	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Structural clay products (e.g., building brick at 1100-1150°C).

HUNTINGDON COUNTY

UNION TOWNSHIP

MOUNT UNION QUADRANGLE

SAMPLE NUMBER 107-A-2F

LOCATION: Exposure along the south side of an access road to a quarry formerly operated by the Pennsylvania Glass Sand Corporation along Sand Ridge south-southwest of Mapleton.

LATITUDE: 40°22'40"N

LONGITUDE: 77°57'14"W

GEOLOGIC UNIT: Marcellus Formation, Devonian

DESCRIPTION: Grayish-black (N2) to black (N1), fissile to platy shale occurs below sample 107-A-2E for a stratigraphic interval of 13 feet (4 m). Dark-yellowish-orange (10YR6/6) to moderate-brown (5YR4/4) iron staining is common along joints and bedding planes. The shale breaks to form papery to platy fragments.

ATTITUDE OF BEDDING: N18E, 75NW

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Channel through 13 feet (4 m) of stratigraphic section

CHEMICAL ANALYSIS:		MINERALOGY (X-RAY):	
	%		Weight %
SiO ₂	61.5	Quartz	20
Al ₂ O ₃	16.90	Mica-smectite	57
Σ"Fe ₂ O ₃ ".....	7.20	Kaolinite	16
MgO.....	1.69	Chlorite-vermiculite	2
CaO.....	0.67	Feldspar	4
Na ₂ O.....	0.97	Calcite	1
K ₂ O.....	3.32		
TiO ₂	0.88		
MnO.....	0.032		
	Total 93.16		

RAW PROPERTIES:
Water of plasticity (%): 15.8
Drying shrinkage (%): 2.5
Workability: Short
Dry strength: Poor
pH: 5.6

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (5YR7/8)	3	2.5	16.7	31.1	1.86
1900						
1050	Mod. orange (5YR7/6)	3	2.5	14.6	28.3	1.93
2000	Grayish reddish orange (2.5YR5/6)	3	5.0	9.4	19.6	2.09
1100						
2100						
1150	Strong brown (2.5YR4/6)	4	5.0	4.9	10.3	2.12
2200						
1200	---	---	Melted	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Marginal for structural clay products (e.g., building brick at 1150°C). Short firing range.

HUNTINGDON COUNTY

UNION TOWNSHIP

MOUNT UNION QUADRANGLE

SAMPLE NUMBER 107-A-2G

LOCATION: Exposure along the south side of an access road to a quarry formerly operated by the Pennsylvania Glass Sand Corporation along Sand Ridge south-southwest of Mapleton.

LATITUDE: 40°22'40"N

LONGITUDE: 77°57'14"W

GEOLOGIC UNIT: Marcellus Formation, Devonian

DESCRIPTION: Grayish-black (N2) to black (N1), fissile to platy shale occurs below sample 107-A-2F for a stratigraphic interval of 12 feet (4 m), where it is in contact with a limestone horizon. Dark-yellowish-orange (10YR6/6) to moderate-brown (5YR4/4) iron staining is common along joints and bedding planes in the shale. The shale breaks to form papery to platy fragments.

ATTITUDE OF BEDDING: N18E, 75NW

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Channel through 12 feet (4 m) of stratigraphic section

CHEMICAL ANALYSIS:

MINERALOGY (X-RAY):

	%
SiO ₂	60.7
Al ₂ O ₃	15.50
Σ"Fe ₂ O ₃ ".....	5.75
MgO.....	1.55
CaO.....	2.48
Na ₂ O.....	0.83
K ₂ O.....	3.25
TiO ₂	0.81
MnO.....	0.033
Total	90.90

	Weight %
Quartz	32
Mica-smectite	60
Kaolinite	0
Chlorite-vermiculite	4
Feldspar	3
Calcite	1

RAW PROPERTIES:

Water of plasticity (%): 15.9
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Fair
 pH: 6.9

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (5YR7/8)	3	2.5	16.5	30.5	1.85
1900						
1050	Mod. orange (5YR6/6)	3	2.5	14.8	28.3	1.91
2000	Grayish reddish orange (2.5YR5/6)	4	2.5	11.5	23.0	2.01
2100						
1150	Strong brown (2.5YR4/6)	5	5.0	6.6	13.8	2.09
2200						
1200	---	---	Melted	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: ND

BLOATING TEST: Negative

REMARKS: Abrupt vitrification between 1150 and 1200°C. Presence of carbonates could cause problems.

POTENTIAL USES: Structural clay products (e.g., building brick at 1100-1150°C).

HUNTINGDON COUNTY

UNION TOWNSHIP

MOUNT UNION QUADRANGLE

SAMPLE NUMBER 107-A-2H

LOCATION: Exposure along the north side of an access road to a quarry formerly operated by the Pennsylvania Glass Sand Corporation along Sand Ridge south-southwest of Mapleton.

LATITUDE: 40°22'40"N

LONGITUDE: 77°57'13"W

GEOLOGIC UNIT: Marcellus Formation, Devonian

DESCRIPTION: Grayish-black (N2) to black (N1), fissile to platy shale is exposed on the north side of the access road below a 9-foot (2.7-m) stratigraphic zone which contains thin limestone beds, contorted shale beds, and shale containing siderite nodules. This zone lies stratigraphically below sample 107-A-2G. The shale collected in sample 107-A-2H has very thin bands of siderite which occur at distances of 13 feet (4 m), 20 feet (6 m), and at various intervals between 20 and 25 feet (6 and 8 m) below the upper contact of the sampled interval. The siderite bands range from 0.25 to 0.50 inch (0.6 to 1.3 cm) in thickness.

ATTITUDE OF BEDDING: N18E, 75NW

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Composite representing 25 stratigraphic feet (8 m)

CHEMICAL ANALYSIS:

MINERALOGY (X-RAY):

	%
SiO ₂	~70.5
Al ₂ O ₃	15.95
Σ"Fe ₂ O ₃ ".....	6.00
MgO.....	1.25
CaO.....	0.92
Na ₂ O.....	0.95
K ₂ O.....	3.10
TiO ₂	0.88
MnO.....	0.027
Total	~99.58

	Weight %
Quartz	36
Mica-smectite	56
Kaolinite	0
Chlorite-vermiculite	3
Feldspar	5
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 15.5
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Poor
 pH: 6.7

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (5YR6/8)	3	2.5	17.8	32.4	1.82
1900						
1050	Brownish orange (5YR5/8)	3	2.5	16.1	30.2	1.88
2000						
1100	Grayish reddish orange (2.5YR5/6)	3	5.0	11.7	23.4	2.00
2100						
1150	Strong brown (2.5YR4/6)	4	5.0	6.6	13.6	2.08
2200						
1200	---	---	Melted	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Short firing range. Abrupt vitrification between 1150 and 1200°C. Presence of carbonates could cause problems.

POTENTIAL USES: Marginal for structural clay products (e.g., building brick at 1150°C).

HUNTINGDON COUNTY

UNION TOWNSHIP

MOUNT UNION QUADRANGLE

SAMPLE NUMBER 107-A-21

LOCATION: Exposure along the north side of an access road to a quarry formerly operated by the Pennsylvania Glass Sand Corporation along Sand Ridge south-southwest of Mapleton.

LATITUDE: 40°22'40"N

LONGITUDE: 77°57'13"W

GEOLOGIC UNIT: Marcellus Formation, Devonian

DESCRIPTION: Grayish-black (N2) to black (N1), fissile to platy shale occurs stratigraphically below sample 107-A-2H on the north side of the access road to the quarry. Thin bands of siderite occur intermittently through the upper half of the sampled interval. The amount of siderite was estimated to be between 4 and 5 percent of the 35 stratigraphic feet (11 m) represented by this sample.

ATTITUDE OF BEDDING: N18E, 75NW

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Composite representing 35 stratigraphic feet (11 m)

CHEMICAL ANALYSIS:

	%
SiO ₂	62.3
Al ₂ O ₃	15.20
Σ"Fe ₂ O ₃ ".....	5.50
MgO.....	1.27
CaO.....	0.92
Na ₂ O.....	0.99
K ₂ O.....	3.12
TiO ₂	0.92
MnO.....	0.024
Total	90.24

MINERALOGY (X-RAY):

	Weight %
Quartz	37
Mica-smectite	52
Kaolinite	0
Chlorite-vermiculite	4
Feldspar	5
Calcite	0
Gypsum	~2

RAW PROPERTIES:

Water of plasticity (%): 15.9
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Poor
 pH: 6.0

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Brownish orange (5YR5/8)	3	2.5	17.5	32.1	1.83
1900						
1050	Brownish orange (5YR5/8)	3	2.5	16.1	31.0	1.86
2000						
1100	Grayish reddish orange (2.5YR5/6)	4	5.0	13.1	25.7	1.96
2100						
1150	Strong brown (2.5YR4/6)	4	5.0	6.6	14.2	2.15
2200						
1200	---	---	Melted	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Abrupt vitrification between 1150 and 1200°C. Presence of carbonates could cause problems.

POTENTIAL USES: Structural clay products (e.g., building brick at 1100-1150°C).

HUNTINGDON COUNTY

UNION TOWNSHIP

MOUNT UNION QUADRANGLE

SAMPLE NUMBER 107-A-2J

LOCATION: Exposure along the north side of an access road to a quarry formerly operated by the Pennsylvania Glass Sand Corporation along Sand Ridge south-southeast of Mapleton.

LATITUDE: 40°22'40"N

LONGITUDE: 77°57'13"W

GEOLOGIC UNIT: Marcellus Formation, Devonian

DESCRIPTION: Grayish-black (N2) to black (N1), very thin bedded shale occurs stratigraphically below sample 107-A-2I on the north side of the access road to the quarry. The shale is slightly calcareous and appears to be "slatelike." The shale breaks to form platy fragments.

ATTITUDE OF BEARING: N18E, 75NW

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Composite representing 36 stratigraphic feet (11 m)

CHEMICAL ANALYSIS:		MINERALOGY (X-RAY):	
	%		Weight %
SiO ₂	59.9	Quartz	26
Al ₂ O ₃	14.90	Mica-smectite	56
Σ"Fe ₂ O ₃ ".....	5.95	Kaolinite	9
MgO.....	1.28	Chlorite-vermiculite	5
CaO.....	2.78	Feldspar	2
Na ₂ O.....	0.66	Calcite	2
K ₂ O.....	3.21		
TiO ₂	0.77	RAW PROPERTIES: Water of plasticity (%): 14.7 Drying shrinkage (%): 2.5 Workability: Short Dry strength: Poor pH: 6.2	
MnO.....	0.027		
Total	89.48		

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (5YR6/8)	3	2.5	16.3	30.3	1.86
1900						
1050	Mod. orange (5YR6/8)	3	2.5	15.1	28.8	1.90
2000	Grayish reddish orange (2.5YR5/6)	4	5.0	11.5	22.9	1.98
1100						
2100	Strong brown (2.5YR4/6)	5	5.0	8.0	16.3	2.03
1150						
2200						
1200	---	---	Melted	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Abrupt vitrification between 1150 and 1200°C. Presence of carbonates could cause problems.

POTENTIAL USES: Structural clay products (e.g., building brick at 1100-1150°C).

HUNTINGDON COUNTY

UNION TOWNSHIP

MOUNT UNION QUADRANGLE

SAMPLE NUMBER 107-A-2K

LOCATION: Exposure along the north side of an access road to a quarry formerly operated by the Pennsylvania Glass Sand Corporation along Sand Ridge south-southeast of Mapleton.

LATITUDE: 40°22'40"N

LONGITUDE: 47°57'13"W

GEOLOGIC UNIT: Marcellus Formation, Devonian

DESCRIPTION: Grayish-black (N2) to black (N1), very thin bedded shale occurs stratigraphically below sample 107-A-2J on the north side of the access road to the quarry. When treated with dilute HCl, the shale effervesces sporadically through the sampled interval, but the reaction is more intense in the lower part near the contact with the underlying Onondaga limestone. The shale is "slatelike" and forms platy fragments when broken. Sampling was terminated about 9 feet (2.7 m) above the contact with the Onondaga limestone.

ATTITUDE OF BEDDING: N18E, 75NW

WEATHERING INTENSITY: Slight to moderate

SAMPLE INTERVAL: Composite representing 36 stratigraphic feet (11 m)

CHEMICAL ANALYSIS:

	%
SiO ₂	56.0
Al ₂ O ₃	14.35
Σ"Fe ₂ O ₃ ".....	5.80
MgO.....	1.60
CaO.....	4.29
Na ₂ O.....	0.67
K ₂ O.....	3.08
TiO ₂	0.65
MnO.....	0.032
Total	86.47

MINERALOGY (X-RAY):

	Weight %
Quartz	25
Mica-smectite	63
Kaolinite	7
Chlorite-vermiculite	1
Feldspar	1
Calcite	3

RAW PROPERTIES:

Water of plasticity (%): 14.8
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Poor
 pH: 6.5

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (5YR6/6)	3	2.5	16.0	30.1	1.88
1900						
1050	Mod. orange (5YR6/6)	3	2.5	15.7	29.5	1.87
2000						
1100	Grayish reddish orange (2.5YR5/6)	4	5.0	13.6	25.9	1.91
2100						
1150	Mod. reddish brown (2.5YR3/4)	6	5.0	7.0	14.5	2.06
2200						
1200	---	---	Melted	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: ND

BLOATING TEST: Negative

REMARKS: Abrupt vitrification between 1150 and 1200°C. Presence of carbonates could cause problems.

POTENTIAL USES: Structural clay products (e.g., building brick at 1100-1150°C).

HUNTINGDON COUNTY

CROMWELL TOWNSHIP

BUTLER KNOB QUADRANGLE

SAMPLE NUMBER 107-C-3A

LOCATION: Abandoned shale quarry east of road leading to Butler Knob, about 1,000 feet (300 m) northwest of Old Womans Gap.

LATITUDE: 40°15'47"N

LONGITUDE: 77°58'24"W

GEOLOGIC UNIT: Reedsville Formation, Ordovician

DESCRIPTION: Light-olive-gray (5Y5/2) to olive-gray (5Y3/2), interbedded shale and silty shale are exposed in this quarry. The beds range in thickness from less than 1/2 inch (1 cm) up to about 4 inches (10 cm). The shale breaks to form platy fragments, whereas the silty shale forms platy to slabby fragments. Iron staining along joints is locally moderate to severe.

ATTITUDE OF BEDDING: N30E, 33SE

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Composite representing 21 feet (6 m) of stratigraphic section

CHEMICAL ANALYSIS:

	%
SiO ₂	62.6
Al ₂ O ₃	16.00
Σ"Fe ₂ O ₃ ".....	7.15
MgO.....	2.00
CaO.....	0.42
Na ₂ O.....	0.54
K ₂ O.....	3.62
TiO ₂	0.98
MnO.....	0.068
Total	93.38

MINERALOGY (X-RAY):

	Weight %
Quartz	27
Mica-smectite	65
Kaolinite	0
Chlorite-vermiculite	4
Feldspar	3
Calcite	1

RAW PROPERTIES:

Water of plasticity (%): 18.1
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Fair
 pH: 7.3

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (2.5YR6/8)	3	2.5	14.4	27.9	1.94
1900						
1050	Brownish orange (2.5YR5/8)	4	5.0	12.3	24.6	2.01
2000						
1100	Strong brown (2.5YR4/8)	5	7.5	6.1	13.6	2.23
2100	Mod. reddish brown					
1150	(2.5YR4/4)	6	10.0	1.9	4.6	2.38
2200	Mod. reddish brown					
1200	(2.5YR3/4)	6	10.0	0.9	2.1	2.44
2300						
1250	---	---	Melted	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Abrupt vitrification between 1100 and 1150°C.

POTENTIAL USES: Structural clay products (e.g., building brick at 1050-1100°C).

HUNTINGDON COUNTY

CROMWELL TOWNSHIP

BUTLER KNOB QUADRANGLE

SAMPLE NUMBER 107-C-3B

LOCATION: Abandoned shale quarry east of the road leading to Butler Knob, about 1,000 feet (300 m) northwest of Old Womans Gap.

LATITUDE: 40°15'47"N

LONGITUDE: 77°58'24"W

GEOLOGIC UNIT: Reedsville Formation, Ordovician

DESCRIPTION: Olive-gray (5Y3/2) to dusky-yellow (5Y6/4), interbedded shale and silty shale occur stratigraphically above sample 107-C-3A. The units range from thickly laminated to thin bedded. The shale and silty shale break to form predominantly platy fragments. Iron staining along joints is locally intense.

ATTITUDE OF BEDDING: N30E, 33SE

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Composite representing 25 stratigraphic feet (8 m)

CHEMICAL ANALYSIS:

	%
SiO ₂	60.5
Al ₂ O ₃	16.60
Σ"Fe ₂ O ₃ ".....	6.90
MgO.....	1.85
CaO.....	0.21
Na ₂ O.....	0.32
K ₂ O.....	3.81
TiO ₂	1.06
MnO.....	0.053
Total	91.30

MINERALOGY (X-RAY):

	Weight %
Quartz	29
Mica-smectite	69
Kaolinite	0
Chlorite-vermiculite	1
Feldspar	1
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 18.9
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Fair
 pH: 7.4

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (2.5YR6/8)	3	2.5	14.6	28.5	1.94
1900						
1050	Brownish orange (2.5YR5/8)	4	5.0	11.6	23.7	2.04
2000						
1100	Strong brown (2.5YR4/8)	4	7.5	5.9	13.5	2.26
2100	Mod. reddish brown (2.5YR4/4)	5	10.0	2.2	5.3	2.35
1150						
2200	Mod. reddish brown (2.5YR3/4)	6	10.0	1.1	2.7	2.42
1200						
2300						
1250	---	---	Melted	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Abrupt vitrification between 1050 and 1100°C.

POTENTIAL USES: Structural clay products (e.g., building brick at 1050°C).

HUNTINGDON COUNTY CROMWELL TOWNSHIP BUTLER KNOB QUADRANGLE
SAMPLE NUMBER 107-C-3C

LOCATION: Exposure along the road south of an abandoned shale quarry located along the east side of the road leading to Butler Knob, about 1,000 feet (300 m) northwest of Old Womans Gap.

LATITUOE: 40°15'43"N LONGITUOE: 77°58'23"W

GEOLOGIC UNIT: Reedsville Formation, Ordovician

DESCRIPTION: Grayish-black (N2) interbedded shale and silty shale are exposed along the road south of the quarry. The beds are thin, ranging in thickness from 1 to 3 inches (3 to 8 cm). The shale and silty shale break to form predominantly platy to flaggy fragments. Iron staining is common along fractures. Slight effervescence occurs in some beds when treated with dilute HCl.

ATTITUOE OF BEOOING: N30E, 33SE

WEATHERING INTENSITY: ---

SAMPLEO INTERVAL: Channel through 15 stratigraphic feet (5 m)

CHEMICAL ANALYSIS:		MINERALOGY (X-RAY):	
	%		Weight %
SiO ₂	65.0	Quartz	28
Al ₂ O ₃	16.05	Mica-smectite	51
Σ"Fe ₂ O ₃ ".....	6.90	Kaolinite	13
MgO.....	2.50	Chlorite-vermiculite	1
CaO.....	0.84	Feldspar	6
Na ₂ O.....	1.20	Calcite	1
K ₂ O.....	3.23		
TiO ₂	0.92		
MnO.....	0.110		
Total			
	96.75		

RAW PROPERTIES:
Water of plasticity (%): 15.1
Orying shrinkage (%): 2.5
Workability: Short
Dry strength: Fair
pH: 7.5

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (2.5YR6/8)	3	2.5	13.7	27.0	1.97
1900						
1050	Brownish orange (2.5YR5/8)	3	2.5	12.3	24.9	2.02
2000						
1100	Mod. reddish brown (2.5YR4/4)	4	5.0	6.7	14.6	2.19
2100						
1150	---	---	Melted	---	---	---
2200						
1200	---	---	---	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: --- BLOATING TEST: ---

REMARKS: Short firing range. Abrupt vitrification between 1100 and 1150°C.

POTENTIAL USES: Marginal for structural clay products (e.g., building brick at 1100°C).

JUNIATA COUNTY

SPRUCE HILL TOWNSHIP

MCCOYSVILLE QUADRANGLE

SAMPLE NUMBER 117-B-8

LOCATION: Abandoned quarry on the north side of a medium-duty road that leads eastward from McCoysville to Path. The quarry is located about 2.4 miles (3.8 km) by road from McCoysville.

LATITUDE: 40°27'12"N

LONGITUDE: 77°31'51"W

GEOLOGIC UNIT: Mahantango Formation, Oevonian

DESCRIPTION: Olive-gray (5Y4/1), very thin bedded, slightly silty shale is exposed in the quarry. The shale breaks to form predominantly platy fragments. Iron oxide and some manganese oxide stains are present along bedding planes and fracture surfaces.

ATTITUDE OF BEDDING: N47E, 47NW

WEATHERING INTENSITY: Moderate

SAMPLED INTERVAL: Channel sample through 17 feet (5 m) of stratigraphic section

CHEMICAL ANALYSIS:

	%
SiO ₂	64.8
Al ₂ O ₃	16.25
Σ"Fe ₂ O ₃ ".....	7.12
MgO.....	1.91
CaO.....	0.12
Na ₂ O.....	1.03
K ₂ O.....	3.28
TiO ₂	1.07
MnO.....	0.049
Total	95.63

MINERALOGY (X-RAY):

	Weight %
Quartz	32
Mica-smectite	55
Kaolinite	1
Chlorite-vermiculite	5
Feldspar	7
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 20.0
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Fair
 pH: 7.2

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Brownish orange (2.5YR5/8)	5	5.0	11.3	22.7	2.01
1900						
1050	Strong brown (2.5YR4/8)	6	7.5	4.2	9.5	2.29
2000						
1100	Mod. reddish brown (2.5YR3/4)	7	10.0	0.6	1.4	2.26
2100						
1150	Mod. reddish brown (2.5YR3/4)	7	5.0	0.0	0.00	2.76
2200						
1200	---	---	Expanded	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Abrupt vitrification between 1000 and 1050°C.

POTENTIAL USES: Building brick at 1000°C.

JUNIATA COUNTY

TUSCARORA TOWNSHIP

McCOYSVILLE QUADRANGLE

SAMPLE NUMBER 117-B-9

LOCATION: Exposure along the southeast side of the medium-duty road that connects McCoyville and McCullochs Mills; the exposure is about 0.80 mile (1.3 km) southwest of McCoyville.

LATITUDE: 40°26'40"N

LONGITUDE: 77°34'48"W

GEOLOGIC UNIT: Marcellus Formation, Devonian

DESCRIPTION: Black (N1), fissile, carbonaceous shale of the Marcellus Formation is exposed at this site. The shale breaks to form papery to platy fragments. The upper 2 feet (0.6 m) of sampled shale has heavy iron oxide staining along bedding planes and fracture surfaces.

ATTITUDE OF BEDDING: N52E, 34SE

WEATHERING INTENSITY: Moderate

SAMPLED INTERVAL: Channel sample through 10 feet (3 m) of stratigraphic section

CHEMICAL ANALYSIS:

MINERALOGY (X-RAY):

	%
SiO ₂	68.7
Al ₂ O ₃	15.15
Σ"Fe ₂ O ₃ ".....	6.11
MgO.....	1.01
CaO.....	0.08
Na ₂ O.....	0.32
K ₂ O.....	3.32
TiO ₂	0.77
MnO.....	0.009
Total	95.47

	Weight %
Quartz	31
Mica-smectite	66
Kaolinite	0
Chlorite-vermiculite	1
Feldspar	2
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 19.5
 Drying shrinkage (%): 5.0
 Workability: Short
 Dry strength: Fair
 pH: 5.6

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800 1000	Mod. to strong orange (2.5YR6/10)	5	5.0	13.1	25.1	1.90
1900 1050	Brownish orange (2.5YR5/8)	6	7.5	8.8	17.9	2.02
2000 1100	Strong brown (2.5YR4/6)	7	10.0	4.0	8.1	2.02
2100 1150	Strong brown (2.5YR4/6)	7.5	5.0	3.4	6.9	2.04
2200 1200	---	---	Expanded	---	---	---
2300 1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Facing brick at 1000-1150°C.

JUNIATA COUNTY

TUSCARORA TOWNSHIP

McCOYSVILLE QUADRANGLE

SAMPLE NUMBER 117-B-10

LOCATION: Abandoned quarry on the south side of medium-duty road that follows McKinley Run; the quarry is located approximately 0.65 mile (1.05 km) east of McCoyville.

LATITUDE: 40°27'04"N

LONGITUDE: 77°33'27"W

GEOLOGIC UNIT: Mahantango Formation, Devonian

DESCRIPTION: Olive-gray (5Y4/1), very thin bedded shale is exposed in this abandoned quarry. Beds average less than 0.5 inch (1.3 cm) in thickness and break to form platy fragments. The quarry measures approximately 50 by 50 by 300 feet (15 by 15 by 90 m).

ATTITUDE OF BEARING: N75-80E, 17-24SE

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Channel sample through 12 feet (4 m) of stratigraphic section

CHEMICAL ANALYSIS:

	%
SiO ₂	61.4
Al ₂ O ₃	16.15
Σ"Fe ₂ O ₃ ".....	6.80
MgO.....	1.82
CaO.....	1.11
Na ₂ O.....	0.81
K ₂ O.....	3.71
TiO ₂	0.95
MnO.....	0.048
Total	92.80

MINERALOGY (X-RAY):

	Weight %
Quartz	25
Mica-smectite	64
Kaolinite	3
Chlorite-vermiculite	4
Feldspar	3
Calcite	1

RAW PROPERTIES:

Water of plasticity (%): 20.7
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Fair
 pH: 8.1

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800	Brownish orange					
1000	(2.5YR5/8)	5	5.0	10.7	21.5	2.02
1900	Strong brown					
1050	(2.5YR4/8)	7	10.0	2.6	5.9	2.30
2000						
1100	---	---	Melted	---	---	---
2100						
1150	---	---	---	---	---	---
2200						
1200	---	---	---	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Abrupt vitrification between 1000 and 1050°C.

POTENTIAL USES: Building brick at 1000°C (marginal use).

JUNIATA COUNTY

LACK TOWNSHIP

BLAIRS MILLS QUADRANGLE

SAMPLE NUMBER 117-C-7

LOCATION: Road exposure along the south flank of Grey Ridge, about 200 feet (60 m) north-west of the road intersection near McCabe Chapel.

LATITUDE: 40°19'03"N

LONGITUDE: 77°41'33"W

GEOLOGIC UNIT: Devonian marine units

DESCRIPTION: Olive-gray (5Y4/1) to greenish-gray (5G6/1), fissile to thin-bedded silty shale is exposed in this roadcut. The silty shale breaks into predominantly platy fragments. The northwestern portion of this exposure includes some sandstone beds.

ATTITUDE OF BEDDING: N42E, 33NW

WEATHERING INTENSITY: Moderate

SAMPLED INTERVAL: Composite representing 15 feet (5 m) of stratigraphic section at south-east end of exposure

CHEMICAL ANALYSIS:		MINERALOGY (X-RAY):	
	%		Weight %
SiO ₂	59.3	Quartz	29
Al ₂ O ₃	18.10	Mica-smectite	63
Σ"Fe ₂ O ₃ "......	6.94	Kaolinite	0
MgO.....	1.55	Chlorite-vermiculite	7
CaO.....	0.16	Feldspar	1
Na ₂ O.....	0.37	Calcite	0
K ₂ O.....	4.20		
TiO ₂	0.97	RAW PROPERTIES: Water of plasticity (%): 19.9 Drying shrinkage (%): 2.5 Workability: Short Dry strength: Fair pH: 7.2	
MnO.....	0.065		
Total	91.66		

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800 1000	Strong orange (2.5YR6/12)	5	5.0	10.1	22.1	2.00
1900 1050	Brownish to deep orange (2.5YR5/10)	6	7.5	6.2	13.6	2.19
2000 1100	Strong brown (2.5YR4/6)	7	10.0	1.0	2.3	2.35
2100 1150	---	---	Expanded	---	---	---
2200 1200	---	---	---	---	---	---
2300 1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Abrupt vitrification between 1050 and 1100°C.

POTENTIAL USES: Building brick at 1000-1050°C.

JUNIATA COUNTY

FERMANAGH TOWNSHIP

MEXICO QUADRANGLE

SAMPLE NUMBER 126-D-4

LOCATION: Quarry on the north side of Pa. Route 35, about 2.1 miles (3.4 km) by road from Mifflintown.

LATITUDE: 40°35'16"N

LONGITUDE: 77°22'05"W

GEOLOGIC UNIT: Bloomsburg Formation, Silurian

DESCRIPTION: Grayish-red (10R4/2), thin-bedded silty shale and shaly siltstone are interbedded in this quarry exposure. The beds range in thickness from 1 to 2 inches (3 to 5 cm) and break to form platy, flaggy, slabby, and a few blocky fragments.

ATTITUDE OF BEDDING: N52E, 33SE

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Composite representing 10 feet (3 m) of stratigraphic section

CHEMICAL ANALYSIS:

	%
SiO ₂	70.5
Al ₂ O ₃	13.45
Σ"Fe ₂ O ₃ ".....	6.99
MgO.....	1.18
CaO.....	0.12
Na ₂ O.....	0.43
K ₂ O.....	3.41
TiO ₂	0.97
MnO.....	0.013
Total	97.06

MINERALOGY (X-RAY):

	Weight %
Quartz	29
Mica-smectite	63
Kaolinite	1
Chlorite-vermiculite	4
Feldspar	3
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 15.4
 Drying shrinkage (%): 5.0
 Workability: Short
 Dry strength: Poor
 pH: 7.0

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Brownish orange (2.5YR5/B)	3	5.0	13.1	22.5	2.00
1900						
1050	Brownish orange (2.5YR5/8)	5	5.0	11.2	26.4	2.02
2000						
1100	Strong brown (2.5YR4/6)	6	10.0	3.6	8.3	2.28
2100						
1150	Mod. reddish brown (2.5YR3/4)	7	12.5	1.6	3.7	2.34
2200						
1200	---	---	Melted	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Abrupt vitrification between 1050 and 1100°C.

POTENTIAL USES: Building brick at 1050°C.

JUNIATA COUNTY

MONROE TOWNSHIP

BEAVER SPRINGS QUADRANGLE

SAMPLE NUMBER 136-A-24

LOCATION: Quarry owned by James Neimond & Sons, Kellerville, Pennsylvania. The quarry is located southeast of the road intersection at Kellerville.

LATITUDE: 40°39'34"N

LONGITUDE: 77°09'37"W

GEOLOGIC UNIT: Mahantango Formation, Devonian

DESCRIPTION: Light-olive-gray (5Y5/2) silty claystone and shale are exposed in this quarry. The claystone and shale break to form hackly and rubbly fragments. The quarried rock is currently being used for road-building material and fill.

ATTITUDE OF BEDDING: N20E, 10SE

WEATHERING INTENSITY: Moderate

SAMPLED INTERVAL: Channel sample through 15 feet (5 m) of stratigraphic section of claystone and shale

CHEMICAL ANALYSIS:

	%
SiO ₂	61.3
Al ₂ O ₃	18.60
Σ"Fe ₂ O ₃ ".....	6.64
MgO.....	1.29
CaO.....	0.17
Na ₂ O.....	0.51
K ₂ O.....	4.23
TiO ₂	1.03
MnO.....	0.032
Total	93.80

MINERALOGY (X-RAY):

	Weight %
Quartz	23
Mica-smectite	65
Kaolinite	7
Chlorite-vermiculite	3
Feldspar	2
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 20.0
 Drying shrinkage (%): 5.0
 Workability: Short
 Dry strength: Fair
 pH: 6.1

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Brownish orange (2.5YR5/8)	5	7.5	10.8	21.7	2.01
1900						
1050	Brownish orange (2.5YR5/8)	6	7.5	7.7	16.2	2.11
2000						
1100	Strong brown (2.5YR4/8)	7	10.0	0.0	0.0	2.43
2100						
1150	---	---	Expanded	---	---	---
2200						
1200	---	---	---	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: ND

BLOATING TEST: Negative

REMARKS: Abrupt vitrification between 1050 and 1100°C.

POTENTIAL USES: Building brick at 1000-1050°C.

JUNIATA COUNTY

SUSQUEHANNA TOWNSHIP

RICHFIELD QUADRANGLE

SAMPLE NUMBER 136-B-28

LOCATION: Quarry on the west side of a medium-duty road, about 1.75 miles (2.80 km) north of the village of Oriental and just northwest of the Ken-Mar Hotel.

LATITUDE: 40°39'26"N

LONGITUDE: 77°00'36"W

GEOLOGIC UNIT: Trimmers Rock Formation, Devonian

DESCRIPTION: Light-olive-gray (5Y5/2), thin-bedded, very silty shale and shaly siltstone are exposed in this quarry. The beds range from 3 to 4 inches (8 to 10 cm) in thickness, and break to form predominantly slabby fragments.

ATTITUDE OF BEDDING: N50E, 28SE

WEATHERING INTENSITY: Moderate

SAMPLED INTERVAL: Channel sample through 10 feet (3 m) of stratigraphic section

CHEMICAL ANALYSIS:

	%
SiO ₂	67.0
Al ₂ O ₃	15.45
Σ"Fe ₂ O ₃ ".....	6.63
MgO.....	1.40
CaO.....	0.15
Na ₂ O.....	0.51
K ₂ O.....	3.15
TiO ₂	1.02
MnO.....	0.067
Total	95.38

MINERALOGY (X-RAY):

	Weight %
Quartz	31
Mica-smectite	59
Kaolinite	0
Chlorite-vermiculite	8
Feldspar	2
Calcite	0

RAW PROPERTIES:

Water of plasticity (%):	17.5
Drying shrinkage (%):	2.5
Workability:	Short
Dry strength:	Poor
pH:	7.1

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800 1000	Brownish to deep orange (2.5YR5/10)	3	2.5	15.7	28.9	1.84
1900 1050	Brownish orange (2.5YR5/8)	4	5.0	14.9	27.7	1.86
2000 1100	Mod. to strong yellow (2.5Y7/8)	5	7.5	11.9	22.9	1.93
2100 1150	Mod. yellow (2.5Y7/6)	6	7.5	7.3	15.2	2.06
2200 1200	Mod. olive brown (2.5Y3/7)	7	7.5	2.4	5.1	2.11
2300 1250	---	---	Expanded	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

8LOATING TEST: Negative

REMARKS: Good firing range.

POTENTIAL USES: Facing brick at 1050-1200°C.

JUNIATA COUNTY

DELAWARE TOWNSHIP

MILLERSTOWN QUADRANGLE

SAMPLE NUMBER 136-C-23

LOCATION: Roadcut exposure about 100 feet (30 m) down the Thompsontown exit ramp from the westbound lane of U. S. Route 22-322.

LATITUDE: 40°34'10"N

LONGITUDE: 77°13'52"W

GEOLOGIC UNIT: Marcellus Formation, Devonian

DESCRIPTION: Grayish-black (N2), fissile, carbonaceous shale of the Marcellus Formation is exposed in this roadcut. The shale breaks to form papery fragments. Dark-yellowish-orange iron staining is present along fractures and bedding planes.

ATTITUDE OF BEDDING: Reliable measurement prevented because beds were complexly folded

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Composite sample representing 15 feet (5 m) of stratigraphic section

CHEMICAL ANALYSIS:

MINERALOGY (X-RAY):

	%
SiO ₂	62.3
Al ₂ O ₃	14.25
Σ ^{IV} Fe ₂ O ₃	6.23
MgO.....	1.18
CaO.....	0.47
Na ₂ O.....	0.48
K ₂ O.....	3.40
TiO ₂	0.69
MnO.....	0.022
Total	89.02

	Weight %
Quartz	27
Mica-smectite	68
Kaolinite	1
Chlorite-vermiculite	3
Feldspar	1
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 20.1
 Drying shrinkage (%): 2.5
 Workability: Plastic
 Dry strength: Fair
 pH: 6.7

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800 1000	Brownish orange (2.5YR5/8)	4	5.0	16.7	29.8	1.79
1900 1050	Strong brown (2.5YR4/8)	5	5.0	10.9	21.0	1.93
2000 1100	---	---	Melted	---	---	---
2100 1150	---	---	---	---	---	---
2200 1200	---	---	---	---	---	---
2300 1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Abrupt vitrification between 1050 and 1100°C.

POTENTIAL USES: Building brick at 1000-1050°C.

JUNIATA COUNTY

GREENWOOD TOWNSHIP

MILLERSTOWN QUADRANGLE

SAMPLE NUMBER 136-C-25

LOCATION: Exposure along the northwest side of a medium-duty road, approximately 1,500 feet (460 m) west of Oimmsville.

LATITUDE: 40°36'22"N

LONGITUDE: 77°08'32"W

GEOLOGIC UNIT: Sherman Ridge Member, Mahantango Formation, Devonian

DESCRIPTION: Olive-black (5Y2/1) silty claystone of the Mahantango Formation occurs in this exposure. A few siderite nodules, having long dimensions up to 2 inches (5 cm), are scattered throughout the sampled interval. The claystone displays spheroidal weathering, and breaks to form splintery, platy, or slabby fragments. Iron and manganese oxides occur as coatings along bedding planes and fracture surfaces.

ATTITUDE OF EXPOSURE: NE-SW, 9SE

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL:

CHEMICAL ANALYSIS:

	%
SiO ₂	61.6
Al ₂ O ₃	18.35
Σ"Fe ₂ O ₃ ".....	6.49
MgO.....	1.62
CaO.....	0.48
Na ₂ O.....	0.70
K ₂ O.....	4.12
TiO ₂	0.97
MnO.....	0.050
Total	94.38

MINERALOGY (X-RAY):

	Weight %
Quartz	26
Mica-smectite	67
Kaolinite	0
Chlorite-vermiculite	3
Feldspar	3
Calcite	1

RAW PROPERTIES:

Water of plasticity (%): 16.5
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Poor
 pH: 7.8

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800	Brownish orange					
1000	(2.5YR5/8)	5	5.0	9.9	20.5	2.07
1900	Grayish reddish orange					
1050	(2.5YR5/6)	6	7.5	5.2	11.6	2.24
2000						
1100	---	---	Expanded	---	---	---
2100						
1150	---	---	---	---	---	---
2200						
1200	---	---	---	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: ND

BLOATING TEST: Positive

REMARKS: Slight effervescence when treated with HCl.

BLOATING TEST (QUICK-FIRING):

Temp. (°F) (°C)	Bulk density ³ (g/cc) (lb/ft ³)		% Absorb.	Remarks
1800 1000	1.90	118.6	13.8	Slight expansion.
1900 1050	1.69	105.5	6.4	Slight expansion.
2000 1100	1.64	102.3	7.0	Slight expansion.
2100 1150	0.79	49.3	8.9	Some large pores.
2200 1200	--	--	--	--
2300 1250	--	--	--	--

REMARKS: Marginal use for lightweight aggregate because of short firing range.

POTENTIAL USES: Building brick at 1000-1050°C. Marginal use for lightweight aggregate.

JUNIATA COUNTY

GREENWOOD TOWNSHIP

REWARD QUADRANGLE

SAMPLE NUMBER 136-D-26

LOCATION: Quarry along the north side of Pa. Route 235, approximately 0.75 mile (1.2 km) west of the village of Seven Stars.

LATITUDE: 40°36'55"N

LONGITUDE: 77°07'11"W

GEOLOGIC UNIT: Sherman Ridge Member, Mahantango Formation, Devonian

DESCRIPTION: Olive-gray (5Y4/1), fossiliferous, massive silty claystone is exposed in this quarry. The claystone consistently displays an ellipsoidal or spheroidal exfoliation, and breaks to form hackly, platy, and some slabby fragments. A bluish-black coating of manganese(?) oxide occurs on bedding planes and fracture surfaces.

ATTITUDE OF 8E00ING: NW-SE, 7NE

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Composite sample representative of 20 feet (6 m) of stratigraphic section

CHEMICAL ANALYSIS:

	%
SiO ₂	64.5
Al ₂ O ₃	16.85
Σ"Fe ₂ O ₃ ".....	6.57
MgO.....	1.48
CaO.....	0.15
Na ₂ O.....	0.87
K ₂ O.....	3.44
TiO ₂	1.00
MnO.....	0.051
Total	94.91

MINERALOGY (X-RAY):

	Weight %
Quartz	31
Mica-smectite	59
Kaolinite	3
Chlorite-vermiculite	3
Feldspar	4
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 16.8
 Drying shrinkage (%): 5.0
 Workability: Short
 Dry strength: Poor
 pH: 6.7

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800	Brownish to deep orange					
1000	(2.5YR5/10)	4	5.0	10.8	21.2	2.08
1900	Brownish orange					
1050	(2.5YR5/8)	5	7.5	7.6	14.8	2.13
2000	Mod. reddish brown					
1100	(2.5YR3/4)	6	10.0	1.4	3.3	2.31
2100						
1150	---	---	Expanded	---	---	---
2200						
1200	---	---	---	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Abrupt vitrification between 1050 and 1100°C.

POTENTIAL USES: Building brick at 1000-1050°C.

JUNIATA COUNTY

GREENWOOD TOWNSHIP

REWARD QUADRANGLE

SAMPLE NUMBER 136-D-27

LOCATION: Quarry along the east side of a light-duty road, about 0.60 mile (980 m) north-northeast of the village of Seven Stars.

LATITUDE: 40°37'20"N

LONGITUDE: 77°06'13"W

GEOLOGIC UNIT: Trimmers Rock Formation, Devonian

DESCRIPTION: Interbedded light-olive-gray (5Y5/2) and medium-gray (N5) silty shale and siltstone, probably within the lower 200 feet (61 m) of the Trimmers Rock Formation, are exposed in this quarry. The silty shale is more prevalent than the siltstone. The silty shale breaks to form platy fragments, whereas the siltstone forms flaggy to slabby fragments. The thicknesses of beds range from 1 to 4 inches (3 to 10 cm).

ATTITUDE OF BEDDING: N85E, 14NW

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Channel sample through 10 feet (3 m) of stratigraphic section

CHEMICAL ANALYSIS:

	%
SiO ₂	63.2
Al ₂ O ₃	18.70
Σ"Fe ₂ O ₃ ".....	7.73
MgO.....	1.58
CaO.....	0.37
Na ₂ O.....	0.61
K ₂ O.....	3.66
TiO ₂	0.99
MnO.....	0.068
Total	96.91

MINERALOGY (X-RAY):

	Weight %
Quartz	24
Mica-smectite	69
Kaolinite	0
Chlorite-vermiculite	5
Feldspar	2
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 17.8
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Poor
 pH: 7.5

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800	Brownish to deep orange					
1000	(2.5YR5/10)	4	5.0	10.9	22.8	2.02
1900	Brownish orange					
1050	(2.5YR5/8)	5	7.5	6.8	14.8	2.17
2000	Mod. reddish brown					
1100	(2.5YR3/4)	6	7.5	1.7	3.9	2.27
2100	Mod. reddish brown					
1150	(2.5YR3/4)	7	10.0	0.7	1.5	2.29
2200						
1200	---	---	Expanded	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Building brick at 1000-1050°C.

MIFFLIN COUNTY

WAYNE TOWNSHIP

MOUNT UNION QUADRANGLE

SAMPLE NUMBER 107-A-4

LOCATION: Exposure along the southernmost portion of a light-duty road leading northwest from U. S. Route 22 at Lucy Furnace.

LATITUDE: 40°23'34"N

LONGITUDE: 77°53'12"W

GEOLOGIC UNIT: Rose Hill Formation, Clinton Group, Silurian

DESCRIPTION: A sequence of interbedded fissile shale and thin-bedded shaly siltstone, and siltstone are exposed at this locality. Colors of the rocks are varied, including brown, light olive gray (5Y5/2), moderate olive brown (5Y4/4), dark yellow brown (10Y4/2), light olive brown (5Y5/6), and grayish red (10R4/2). The siltstone beds are up to 1-5/8 inches (4 cm) in thickness. Fragments range from papery to chippy.

ATTITUDE OF BEDDING: N8E, 24SE

WEATHERING INTENSITY: Moderate to slight

SAMPLED INTERVAL: Channel through 14 stratigraphic feet (4 m)

CHEMICAL ANALYSIS:

	%
SiO ₂	58.5
Al ₂ O ₃	19.35
Σ"Fe ₂ O ₃ ".....	7.25
MgO.....	1.36
CaO.....	0.32
Na ₂ O.....	0.26
K ₂ O.....	4.37
TiO ₂	0.94
MnO.....	0.094
Total	92.44

MINERALOGY (X-RAY):

	Weight %
Quartz	24
Mica-smectite	71
Kaolinite	0
Chlorite-vermiculite	4
Feldspar	1
Calcite	0

RAW PROPERTIES:

Water of plasticity (%):	17.2
Drying shrinkage (%):	2.5
Workability:	Short
Dry strength:	Fair
pH:	6.7

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (5YR7/8)	3	2.5	13.7	27.0	1.96
1900						
1050	Mod. orange (5YR6/8)	3	5.0	11.4	23.5	2.06
2000						
1100	Strong brown (2.5YR4/8)	4	7.5	5.0	11.7	2.33
2100						
1150	Mod. reddish brown (2.5YR4/4)	6	10.0	2.2	5.5	2.43
2200						
1200	Mod. reddish brown (2.5YR3/4)	7	10.0	0.7	1.8	2.45
2300						
1250	---	---	Melted	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Structural clay products (e.g., building brick at 1100-1150°C).

MIFFLIN COUNTY

WAYNE TOWNSHIP

MOUNT UNION QUADRANGLE

SAMPLE NUMBER 107-A-5

LOCATION: Exposure along the north side of U. S. Route 522 about 0.3 mile (460 m) north-east of the place where Furnace Run crosses under Route 522.

LATITUDE: 40°23'42"N

LONGITUDE: 77°52'37"W

GEOLOGIC UNIT: Bloomsburg Formation, Silurian

DESCRIPTION: Grayish-red (5R5/4) to olive-gray (5Y3/2), calcareous shale and claystone are exposed along the north side of U. S. Route 522 at this location. The sampled interval is stratigraphically in the upper member of the Bloomsburg Formation and its upper contact is defined as the base of a dolomite bed which belongs in the overlying Wills Creek Formation. The shale and claystone in the Bloomsburg Formation break into small hackly fragments.

ATTITUDE OF BE00ING: N27E, 28SE

WEATHERING INTENSITY: Slight

SAMPLED INTERVAL: Composite representing 40 stratigraphic feet (12 m)

CHEMICAL ANALYSIS:

	%
SiO ₂	47.8
Al ₂ O ₃	15.60
Σ"Fe ₂ O ₃ ".....	7.23
MgO.....	1.89
CaO.....	9.45
Na ₂ O.....	0.15
K ₂ O.....	4.47
TiO ₂	0.85
MnO.....	0.070
Total	87.51

MINERALOGY (X-RAY):

	Weight %
Quartz	13
Mica-smectite	79
Kaolinite	0
Chlorite-vermiculite	2
Feldspar	1
Calcite	5

RAW PROPERTIES:

Water of plasticity (%)	12.9
Drying shrinkage (%)	2.5
Workability:	Short
Dry strength:	Fair
pH:	7.3

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800	Grayish reddish orange					
1000	(2.5YR6/6)	3	2.5	16.5	31.1	1.87
1900	Grayish reddish orange					
1050	(2.5YR6/6)	3	2.5	16.4	30.9	1.88
2000	Grayish reddish orange					
1100	(2.5YR5/6)	3	2.5	16.1	30.5	1.88
2100	Grayish reddish orange					
1150	(2.5YR5/6)	4	2.5	15.9	29.7	1.90
2200	Mod. reddish brown					
1200	(2.5YR4/4)	7	5.0	5.5	11.8	2.14
2300						
1250	---	---	Melted	---	---	---

PYROMETRIC CONE EQUIVALENT: ND

BLOATING TEST: Negative

REMARKS: Abrupt vitrification between 1150 and 1200°C. Presence of carbonates could cause problems.

POTENTIAL USES: Marginal for structural clay products (e.g., building brick at 1150°C).

MIFFLIN COUNTY

WAYNE TOWNSHIP

NEWTON HAMILTON QUADRANGLE

SAMPLE NUMBER 107-B-6

LOCATION: Exposure along the Penn Central railroad tracks about 1 mile (1.6 km) southwest of Newton Hamilton.

LATITUDE: 40°22'57"N

LONGITUDE: 77°51'07"W

GEOLOGIC UNIT: Marcellus Formation, Devonian

DESCRIPTION: Black (N1), carbonaceous, fissile to very thin bedded shale of the Marcellus Formation is exposed at this locality. This shale breaks to form papery to platy fragments. Iron staining is common along fractures and bedding planes.

ATTITUDE OF BEDDING: N25-35E, 8NW

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Channel through lower 10 stratigraphic feet (3 m)

CHEMICAL ANALYSIS:

MINERALOGY (X-RAY):

ANALYSES NOT DONE BECAUSE SAMPLE HAD NO POTENTIAL USES

SiO₂.....
 Al₂O₃.....
 Σ"Fe₂O₃".....
 MgO.....
 CaO.....
 Na₂O.....
 K₂O.....
 TiO₂.....
 MnO.....

Quartz
 Mica-smectite
 Kaolinite
 Chlorite-vermiculite
 Feldspar
 Calcite

Total

RAW PROPERTIES:

Water of plasticity (%): 12.8
 Drying shrinkage (%): 0.0
 Workability: Short
 Dry strength: Poor
 pH: 6.8

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Brownish orange (2.5YR5/8)	3	2.5	13.3	25.0	1.88
1900						
1050	Strong brown (2.5YR4/8)	3	5.0	10.6	21.1	1.98
2000						
1100	Strong brown (2.5YR4/6)	4	7.5	4.8	10.3	2.15
2100						
1150	---	---	Melted	---	---	---
2200						
1200	---	---	---	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Short firing range; high effervescence.

POTENTIAL USES: Not suitable for structural clay products.

MIFFLIN COUNTY

BROWN TOWNSHIP

BARRVILLE QUADRANGLE

SAMPLE NUMBER 116-A-1

LOCATION: Inactive shale pit about 300 feet (90 m) south of Stone Creek Road and about 1.5 miles (2.4 km) west-southwest of the intersection of Stone Creek Road with U. S. Route 322.

LATITUDE: 40°43'31"N

LONGITUDE: 77°39'36"W

GEOLOGIC UNIT: Clinton Group, Silurian

DESCRIPTION: Moderate-brown (5YR4/4) to dark-yellowish-brown (10YR4/2) thin-bedded shale is exposed in this pit, which is 150 feet (46 m) long, 60 feet (18 m) wide, and 30 feet (9 m) high. The shale breaks into platy to flaggy fragments. Iron staining is common along fractures and bedding planes.

ATTITUDE OF BEDDING: N35E, 19SE

WEATHERING INTENSITY: Severe

SAMPLED INTERVAL: Channel through 10 stratigraphic feet (3 m)

CHEMICAL ANALYSIS:

	%
SiO ₂	62.7
Al ₂ O ₃	20.45
Σ"Fe ₂ O ₃ ".....	7.15
MgO.....	1.07
CaO.....	0.05
Na ₂ O.....	0.31
K ₂ O.....	4.56
TiO ₂	1.09
MnO.....	0.058
Total	97.44

MINERALOGY (X-RAY):

	Weight %
Quartz	21
Mica-smectite	77
Kaolinite	0
Chlorite-vermiculite	2
Feldspar	0
Calcite	0

RAW PROPERTIES:

Water of plasticity (%):	18.0
Drying shrinkage (%):	0.0
Workability:	Short
Dry strength:	Fair
pH:	7.2

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (5YR6/8)	3	2.5	13.1	25.9	1.97
1900						
1050	Mod. orange (2.5YR6/8)	3	5.0	10.9	22.1	2.04
2000						
1100	Brownish orange (2.5YR5/8)	4	7.5	6.9	15.1	2.19
2100						
1150	Strong brown (2.5YR4/6)	5	7.5	4.0	9.2	2.29
2200						
1200	---	---	Melted	---	---	---
2300						
1250	---	---	---	---	---	---

PYRDMETRIC CONE EQUIVALENT: ND

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Structural clay products (e.g., building brick at 1100-1150°C).

MIFFLIN COUNTY

ARMAGH TOWNSHIP

BARRVILLE QUADRANGLE

SAMPLE NUMBER 116-A-2

LOCATION: Exposure along the west side of U. S. Route 322 about 45D feet (14D m) north of the place where U. S. Route 322 intersects Stone Creek Road.

LATITUDE: 40°44'03"N

LONGITUDE: 77°38'11"W

GEOLOGIC UNIT: Clinton Group, Silurian

DESCRIPTION: Moderate-yellowish-brown (10YR5/4), dark-yellowish-brown (10YR4/2), and moderate-brown (5YR4/4), thin-bedded shale extends for a distance of about 85D feet (260 m) along the road. The shale breaks to form predominantly platy fragments. Sample was collected at the southern end of this exposure.

ATTITUDE OF BEDDING: N67E

WEATHERING INTENSITY: Severe to moderate

SAMPLED INTERVAL: Composite representing 75 stratigraphic feet (23 m)

CHEMICAL ANALYSIS:

	%
SiO ₂	59.4
Al ₂ O ₃	19.85
Σ"Fe ₂ O ₃ ".....	6.71
MgO.....	D.90
CaO.....	D.12
Na ₂ O.....	D.27
K ₂ O.....	4.89
TiD ₂	1.D5
MnD.....	D.D23
Total	93.21

MINERALOGY (X-RAY):

	Weight %
Quartz	21
Mica-smectite	7D
Kaolinite	9
Chlorite-vermiculite	0
Feldspar	D
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 18.5
 Drying shrinkage (%): D.0
 Workability: Short
 Dry strength: Fair
 pH: 7.D

SLDW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
180D 1DD0	Mod. orange (5YR6/8)	4	2.5	12.5	24.8	1.99
19DD 1D5D	Mod. orange (2.5YR6/8)	4	5.D	9.2	19.5	2.12
2DD0 11DD	Brownish orange (2.5YR5/8)	4	7.5	5.1	11.7	2.27
21DD 115D	Strong brown (2.5YR4/6)	5	7.5	1.5	3.6	2.41
22DD 12DD	Mod. reddish brown (2.5YR3/4)	6	1D.D	D.8	1.8	2.42
23DD 125D	---	---	Melted	---	---	---

PYROMETRIC CONE EQUIVALENT: ND

BLOATING TEST: Negative

REMARKS: Good firing range.

POTENTIAL USES: Structural clay products (e.g., building brick, floor brick at 1DD0-12DD°C).

MIFFLIN COUNTY

UNION TOWNSHIP

BARRVILLE QUADRANGLE

SAMPLE NUMBER 116-A-3

LOCATION: Inactive shale pit on the north side of Barrville Road about 0.75 mile (1.22 km) west of the village of Barrville.

LATITUDE: 40°39'44"N

LONGITUDE: 77°41'27"W

GEOLOGIC UNIT: Reedsville Formation, Ordovician

DESCRIPTION: Olive-gray (5Y4/1), interbedded, thin- to medium-bedded shale and silty shale are exposed in this pit. The thickest bed measures 6 inches (15 cm), but the majority of beds are less than 2 inches (5 cm) thick. These rocks break predominantly to form splintery or platy fragments mixed with some flaggy fragments.

ATTITUDE OF BEDDING: N52E, 58NW

WEATHERING INTENSITY: Moderate

SAMPLED INTERVAL: Channel through 10 stratigraphic feet (3 m)

CHEMICAL ANALYSIS:		MINERALOGY (X-RAY):	
	%		Weight %
SiO ₂	62.1	Quartz	20
Al ₂ O ₃	17.05	Mica-smectite	68
Σ"Fe ₂ O ₃ ".....	7.67	Kaolinite	2
MgO.....	2.20	Chlorite-vermiculite	5
CaO.....	0.17	Feldspar	5
Na ₂ O.....	0.88	Calcite	0
K ₂ O.....	3.78		
TiO ₂	1.03		
MnO.....	0.078		
Total			

RAW PROPERTIES:
Water of plasticity (%): 17.5
Drying shrinkage (%): 0.0
Workability: Short
Dry strength: Fair
pH: 7.0

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800	Brownish to deep orange (2.5YR5/10)	3	5.0	9.9	20.6	2.08
1000						
1900						
1050	Brownish orange (2.5YR5/8)	4	7.5	6.7	14.6	2.18
2000	Strong brown (2.5YR4/6)	4	7.5	3.7	8.4	2.29
1100						
2100						
1150	---	---	Melted	---	---	---
2200	---	---	---	---	---	---
1200						
2300	---	---	---	---	---	---
1250						

PYROMETRIC CONE EQUIVALENT: ND

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Structural clay products (e.g., building brick at 1050-1100°C).

MIFFLIN COUNTY

DERRY TOWNSHIP

BURNHAM QUADRANGLE

SAMPLE NUMBER 116-B-3

LOCATION: Exposure along the west side of U. S. Route 322, about 1.25 miles (2.0 km) north of the Yeagertown exit.

LATITUDE: 40°38'34"N

LONGITUDE: 77°35'07"W

GEOLOGIC UNIT: Bloomsburg Formation, Silurian

DESCRIPTION: Grayish-red (10R4/2), very thin to thin-bedded shale is exposed at this site. The shale breaks to form hackly to platy fragments.

ATTITUDE OF BEDDING: N53E, 82SE

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Composite representing 20 stratigraphic feet (6 m)

CHEMICAL ANALYSIS:

	%
SiO ₂	61.7
Al ₂ O ₃	18.40
Σ"Fe ₂ O ₃ ".....	9.11
MgO.....	1.54
CaO.....	0.28
Na ₂ O.....	0.16
K ₂ O.....	5.33
TiO ₂	1.05
MnO.....	0.036
Total	97.61

MINERALOGY (X-RAY):

	Weight %
Quartz	21
Mica-smectite	77
Kaolinite	0
Chlorite-vermiculite	0
Feldspar	1
Calcite	1

RAW PROPERTIES:

Water of plasticity (%): 12.8
 Drying shrinkage (%): 0.0
 Workability: Short
 Dry strength: Poor
 pH: 7.1

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800	Brownish orange					
1000	(2.5YR5/8)	4	5.0	5.9	13.3	2.27
1900	Grayish reddish orange					
1050	(2.5YR5/6)	4	5.0	3.6	8.5	2.36
2000						
1100	Strong brown (2.5YR4/6)	5	5.0	1.3	3.1	2.44
2100						
1150	---	---	Melted	---	---	---
2200						
1200	---	---	---	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: ND

BLOATING TEST: Negative

REMARKS: Presence of carbonates could cause problems.

POTENTIAL USES: Structural clay products (e.g., building brick at 1000-1100°C).

MIFFLIN COUNTY

DERRY TOWNSHIP

BURNHAM QUADRANGLE

SAMPLE NUMBER 116-B-4

LOCATION: Exposure along the west side of U. S. Route 322 approximately 1.60 miles (2.6 km) north of the Yeagertown exit.

LATITUDE: 40°38'53"N

LONGITUDE: 77°34'59"W

GEOLOGIC UNIT: Rose Hill Formation, Clinton Group, Silurian

DESCRIPTION: Grayish-red (10R4/2) and pale-reddish-brown (10R5/4), very thin to thin-bedded shale of the Rose Hill Formation is exposed along this section of the roadcut. The predominant form of fragments is platy. A minor amount of slabby fragments is mixed with the former.

ATTITUDE OF BEDDING: N53E, 80SE

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Composite representing 35 stratigraphic feet (11 m)

CHEMICAL ANALYSIS:

	%
SiO ₂	55.1
Al ₂ O ₃	19.35
Σ"Fe ₂ O ₃ ".....	8.79
MgO.....	1.47
CaO.....	0.47
Na ₂ O.....	0.22
K ₂ O.....	5.32
TiO ₂	0.94
MnO.....	0.092
Total	91.75

MINERALOGY (X-RAY):

	Weight %
Quartz	15
Mica-smectite	77
Kaolinite	4
Chlorite-vermiculite	3
Feldspar	1
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 18.3
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Fair
 pH: 6.9

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800	Brownish orange (2.5YR5/8)	4	5.0	8.6	18.0	2.10
1900	Grayish reddish orange (2.5YR5/6)	4	7.5	5.5	12.1	2.22
2000						
1100	Strong brown (2.5YR4/6)	5	10.0	2.2	5.3	2.37
2100						
1150	---	---	Melted	---	---	---
2200						
1200	---	---	---	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Structural clay products (e.g., building brick at 1000-1100°C).

MIFFLIN COUNTY

DECATUR TOWNSHIP

ALFARATA QUADRANGLE

SAMPLE NUMBER 126-A-5

LOCATION: Inactive shale pit along the northwest side of a medium-duty road about 0.30 mile (0.48 km) northeast of that road's intersection with U. S. Route 522 at Soradoville.

LATITUDE: 40°41'01"N

LONGITUDE: 77°24'34"W

GEOLOGIC UNIT: Mahantango Formation, Devonian

DESCRIPTION: Light-olive-gray (5Y5/2), light-olive-brown (5Y5/6), and moderate-olive-brown (5Y4/4), interbedded, thin-bedded shale, silty shale, and siltstone are exposed in this pit. The siltstone beds make up about 10 percent of the sampled interval and range in thickness from 1 to 5 inches (3 to 13 cm). Fragments of broken rock are generally platy, but minor percentages are flaggy to slabby. Iron staining is common along fractures and bedding planes.

ATTITUDE OF BEDDING: N58E, 53SE

WEATHERING INTENSITY: Severe

SAMPLED INTERVAL: Channel through 10 stratigraphic feet (3 m)

CHEMICAL ANALYSIS:

	%
SiO ₂	69.3
Al ₂ O ₃	17.10
Σ"Fe ₂ O ₃ ".....	6.13
MgO.....	1.03
CaO.....	0.17
Na ₂ O.....	0.62
K ₂ O.....	3.47
TiO ₂	1.08
MnO.....	0.028
Total	98.93

MINERALOGY (X-RAY):

	Weight %
Quartz	26
Mica-smectite	67
Kaolinite	1
Chlorite-vermiculite	3
Feldspar	3
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 18.8
 Drying shrinkage (%): 0.0
 Workability: Short
 Dry strength: Fair
 pH: 7.1

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (5YR6/8)	3	2.5	14.3	27.5	1.93
1900						
1050	Mod. orange (2.5YR6/8)	4	5.0	11.1	22.5	2.02
2000						
1100	Brownish orange (2.5YR5/8)	4	5.0	7.7	16.7	2.15
2100						
1150	Strong brown (2.5YR4/6)	4	7.5	4.1	9.3	2.26
2200						
1200	Mod. reddish brown (2.5YR4/4)	5	7.5	1.5	3.4	2.30
2300						
1250	---	---	Melted	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Good firing range.

POTENTIAL USES: Structural clay products (e.g., building brick at 1050-1200°C).

MIFFLIN COUNTY

DECATUR TOWNSHIP

ALFARATA QUADRANGLE

SAMPLE NUMBER 126-A-6A

LOCATION: Inactive shale pit located about 1,000 feet (300 m) east of Belltown Cemetery and about 0.4 mile (620 m) west-southwest of the village of Belltown.

LATITUDE: 40°42'39"N

LONGITUDE: 77°25'25"W

GEOLOGIC UNIT: Marcellus Formation, Devonian

DESCRIPTION: Black (N1), carbonaceous, fissile shale is exposed in the northern section of this quarry. The shale breaks into papery fragments. Some iron staining is present along fractures and bedding planes.

ATTITUDE OF BEDDING: N48E, 58SE

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Composite representing 30 stratigraphic feet (9 m)

CHEMICAL ANALYSIS:

	%
SiO ₂	64.2
Al ₂ O ₃	12.75
Σ"Fe ₂ O ₃ ".....	3.22
MgO.....	0.72
CaO.....	0.00
Na ₂ O.....	0.33
K ₂ O.....	2.99
TiO ₂	0.62
MnO.....	0.006
Total	84.84

MINERALOGY (X-RAY):

	Weight %
Quartz	30
Mica-smectite	68
Kaolinite	0
Chlorite-vermiculite	0
Feldspar	1
Calcite	1

RAW PROPERTIES:

Water of plasticity (%): 18.5
 Drying shrinkage (%): 0.0
 Workability: Short
 Dry strength: Fair
 pH: 6.8

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800	Light to mod. yellowish					
1000	pink (5YR8/4)	3	2.5	21.7	35.9	1.65
1900	Light to mod. yellowish					
1050	pink (5YR8/4)	3	2.5	20.4	34.5	1.69
2000	Mod. yellowish pink					
1100	(5YR7/6)	3	5.0	18.0	31.2	1.74
2100						
1150	Strong brown (2.5YR4/6)	4	5.0	9.5	18.5	1.94
2200	Mod. reddish brown					
1200	(2.5YR4/4)	4	5.0	4.5	8.9	1.98
2300						
1250	---	---	Melted	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Presence of carbonates could cause problems.

POTENTIAL USES: Structural clay products (e.g., building brick at 1150-1200°C).

MIFFLIN COUNTY

DECATUR TOWNSHIP

ALFARATA QUADRANGLE

SAMPLE NUMBER 126-A-5B

LOCATION: Inactive shale pit located about 1,000 feet (300 m) east of Belltown Cemetery and about 0.4 mile (620 m) west-southwest of the village of Belltown.

LATITUDE: 40°42'40"N

LONGITUDE: 77°25'26"W

GEOLOGIC UNIT: Marcellus Formation, Devonian

DESCRIPTION: Black (N1), carbonaceous fissile shale and some interbedded siltstone beds are exposed in the southern portion of this excavation. The siltstone makes up about 3 to 4 percent of the interval that was sampled. The beds in this portion of the pit are folded into a syncline. Fragments of the fissile shale are papery. The dimensions of the pit are about 400 feet (120 m) long, 50 feet (15 m) wide, and 30 feet (9 m) high.

ATTITUDE OF BEDDING: Changes due to folding

WEATHERING INTENSITY: ---

SAMPLED INTERVAL: Composite representing 25 stratigraphic feet (8 m)

CHEMICAL ANALYSIS:

	%
SiO ₂	>72
Al ₂ O ₃	14.80
Σ"Fe ₂ O ₃ ".....	4.40
MgO.....	0.82
CaO.....	0.03
Na ₂ O.....	0.29
K ₂ O.....	3.37
TiO ₂	0.75
MnO.....	0.008
Total	>96.47

MINERALOGY (X-RAY):

	Weight %
Quartz	35
Mica-smectite	62
Kaolinite	0
Chlorite-vermiculite	2
Feldspar	1
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 17.3
 Drying shrinkage (%): 0.0
 Workability: Short
 Dry strength: Fair
 pH: 6.7

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800	Light to mod. yellowish					
1000	pink (5YR8/4)	3	2.5	18.1	31.9	1.76
1900	Light to mod. yellowish					
1050	pink (5YR8/4)	3	2.5	16.0	29.4	1.83
2000	Light brown to mod. orange					
1100	(5YR6/6)	4	5.0	11.4	22.4	1.97
2100	Light reddish brown					
1150	(2.5YR5/4)	5	7.5	4.0	8.8	2.12
2200	Mod. reddish brown					
1200	(2.5YR4/4)	5	7.5	1.6	3.4	2.18
2300						
1250	---	---	Melted	--	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Structural clay products (e.g., building brick at 1100-1200°C).

PERRY COUNTY

TOBOYNE TOWNSHIP

BLAIRS MILLS QUADRANGLE

SAMPLE NUMBER 117-C-5

LOCATION: Exposure along the south side of Pa. Route 274, about 1.1 miles (1.75 km) northeast of the entrance to Big Spring State Park.

LATITUDE: 40°16'17"N

LONGITUDE: 77°38'30"W

GEOLOGIC UNIT: Rose Hill Formation, Clinton Group, Silurian

DESCRIPTION: Light-olive-gray (5Y5/2) to grayish-olive (10Y4/2), thin-bedded shale is exposed in a pit, which is approximately 250 by 100 by 25 feet (75 by 30 x 7.5 m) in dimension. The shale breaks to form predominantly platy fragments and some splintery and blocky fragments. Iron staining in moderate amounts is present along fractures and bedding planes. The sample was collected immediately below a purplish "iron sandstone."

ATTITUDE OF BEDDING: N40E, 74SE

WEATHERING INTENSITY: Moderate to severe

SAMPLED INTERVAL: Channel sample through 10 feet (3 m) of stratigraphic section

CHEMICAL ANALYSIS:

	%
SiO ₂	63.2
Al ₂ O ₃	15.95
Σ"Fe ₂ O ₃ ".....	7.18
MgO.....	1.07
CaO.....	0.02
Na ₂ O.....	0.17
K ₂ O.....	3.78
TiO ₂	0.83
MnO.....	0.076
Total	92.28

MINERALOGY (X-RAY):

	Weight %
Quartz	30
Mica-smectite	60
Kaolinite	8
Chlorite-vermiculite	1
Feldspar	1
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 16.4
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Good
 pH: 6.6

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (5YR6/8)	3	2.5	15.6	29.7	1.90
1900						
1050	Mod. orange (5YR6/B)	3	2.5	14.7	28.2	1.92
2000						
1100	Brownish orange (2.5YR5/8)	4	5.0	11.8	24.0	2.03
2100	Mod. reddish brown					
1150	(2.5YR3/4)	5	7.5	7.3	15.9	2.18
2200	Mod. reddish brown					
1200	(10R3/4)	6	7.5	5.1	11.5	2.24
2300	Grayish reddish brown					
1250	(10R3/2)	7	10.0	3.5	8.0	2.27

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Good firing range.

POTENTIAL USES: Facing brick at 1100-1250°C.

PERRY COUNTY

TOBOYNE TOWNSHIP

BLAIN QUADRANGLE

SAMPLE NUMBER 117-D-6

LOCATION: Small exposure along the southeast side of Pa. Route 274, about 1.15 miles (1.85 km) southwest from New Germantown.

LATITUDE: 40°18'06"N

LONGITUDE: 77°35'23"W

GEOLOGIC UNIT: Bloomsburg Formation, Silurian

DESCRIPTION: Grayish-red (10R4/2), thin-bedded, calcareous shale is exposed in an 8-foot- (2.4-m-) high roadcut. The shales break to form platy fragments.

ATTITUDE OF BEDDING: Estimated N45E, dip relatively steep to SE

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Channel sample through about 5 feet (1.5 m) of stratigraphic section

CHEMICAL ANALYSIS:

	%
SiO ₂	50.3
Al ₂ O ₃	16.00
Σ"Fe ₂ O ₃ ".....	7.22
MgO.....	1.49
CaO.....	8.85
Na ₂ O.....	0.24
K ₂ O.....	4.34
TiO ₂	0.87
MnO.....	0.165
Total	89.48

MINERALOGY (X-RAY):

	Weight %
Quartz	16
Mica-smectite	77
Kaolinite	0
Chlorite-vermiculite	0
Feldspar	1
Calcite	6

RAW PROPERTIES:

Water of plasticity (%): 14.6
 Drying shrinkage (%): 0.0
 Workability: Short
 Dry strength: Good
 pH: 7.6

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800	Grayish reddish orange					
1000	(2.5YR5/6)	4	2.5	17.9	32.3	1.80
1900	Grayish reddish orange					
1050	(2.5YR5/6)	4	2.5	17.0	31.2	1.82
2000						
1100	Strong brown (2.5YR4/6)	5	2.5	17.1	31.0	1.83
2100						
1150	---	---	Melted	---	---	---
2200						
1200	---	---	---	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Abrupt vitrification between 1100 and 1150°C. May be limy.

POTENTIAL USES: Building brick at 1000-1100°C.

PERRY COUNTY

TUSCARORA TOWNSHIP

ICKESBURG QUADRANGLE

SAMPLE NUMBER 127-B-7A

LOCATION: Quarry along the southeast side of Pa. Route 849, about 1 mile (1.6 km) north-east of Eshcol.

LATITUDE: 40°27'51"N

LONGITUDE: 77°17'27"W

GEOLOGIC UNIT: Lower part of the Trimmers Rock Formation, Oevonian

DESCRIPTION: Pale-olive (10Y6/2) to olive-gray (5Y3/2), thin- to medium-bedded silty shale is interbedded with a few siltstone beds in this sampled interval. The beds range in thickness from about 1 to 6 inches (3 to 15 cm). The shale breaks down into splintery to platy fragments predominantly. Some iron staining is present along fractures and bedding planes in the shale and siltstone. The approximate dimensions of this quarry are 150 by 75 by 20 feet (46 by 23 by 6 m).

ATTITUDE OF BEDDING: N60E, 32SE

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Channel sample through 10 feet (3 m) of stratigraphic section

CHEMICAL ANALYSIS:		MINERALOGY (X-RAY):	
	%		Weight %
SiO ₂	65.0	Quartz	25
Al ₂ O ₃	18.70	Mica-smectite	72
Σ"Fe ₂ O ₃ ".....	7.76	Kaolinite	0
MgO.....	1.67	Chlorite-vermiculite	1
CaO.....	0.21	Feldspar	2
Na ₂ O.....	0.40	Calcite	0
K ₂ O.....	3.97		
TiO ₂	1.01		
MnO.....	0.032		
Total	98.75		

RAW PROPERTIES:
Water of plasticity (%): 15.4
Orying shrinkage (%): 2.5
Workability: Short
Ory strength: Good
pH: 6.8

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800	Brownish orange					
1000	(2.5YR5/8)	6	5.0	12.3	24.8	2.01
1900	Brownish orange					
1050	(2.5YR5/8)	6	5.0	11.6	23.6	2.04
2000	Strong brown					
1100	(2.5YR4/8)	6	5.0	6.5	14.5	2.23
2100	Mod. reddish brown					
1150	(2.5YR3/4)	8	10.0	1.6	3.8	2.34
2200						
1200	---	---	Melted	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Positive

REMARKS: ---

BLOATING TEST (QUICK-FIRING):

Temp. (°F) (°C)	Bulk density ³ (g/cc) (lb/ft ³)		% Absorb.	Remarks
1800 1000	--	--	--	--
1900 1050	1.83	114.4	5.1	Slight expansion.
2000 1100	1.30	80.2	5.4	Good pore structure.
2100 1150	1.15	71.8	4.7	Good pore structure.
2200 1200	0.78	48.7	7.8	Overfired.
2300 1250	--	--	--	--

REMARKS: Marginal use as lightweight aggregate. (Slightly heavy.)

POTENTIAL USES: Facing brick at 1000-1100°C; marginal lightweight aggregate.

PERRY COUNTY

TUSCARORA TOWNSHIP

ICKESBURG QUADRANGLE

SAMPLE NUMBER 127-B-7B

LOCATION: Quarry along the southeast side of Pa. Route 849, about 1 mile (1.6 km) northeast of Eshcol.

LATITUDE: 40°27'51"N

LONGITUDE: 77°17'27"W

GEOLOGIC UNIT: Lower part of the Trimmers Rock Formation, Devonian

DESCRIPTION: Pale-olive (10Y6/2) to olive-gray (5Y3/2), thin- to medium-bedded silty shale occurs below sample 127-B-7A. The beds range in thickness from about 1 to 6 inches (3 to 15 cm). The shale breaks to form splintery to platy fragments. Some iron staining is present along fractures and bedding planes.

ATTITUDE OF BEDDING: N60E, 32SE

WEATHERING INTENSITY: Moderate

SAMPLED INTERVAL: Channel sample through 7 feet (2.1 m) of stratigraphic section

CHEMICAL ANALYSIS:

MINERALOGY (X-RAY):

	%
SiO ₂	64.6
Al ₂ O ₃	19.90
Σ"Fe ₂ O ₃ ".....	6.38
MgO.....	1.05
CaO.....	0.07
Na ₂ O.....	0.29
K ₂ O.....	4.23
TiO ₂	0.99
MnO.....	0.032
Total	97.54

	Weight %
Quartz	23
Mica-smectite	71
Kaolinite	0
Chlorite-vermiculite	4
Feldspar	2
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 16.6
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Good
 pH: 5.9

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (5YR6/8)	5	5.0	13.1	25.8	1.98
1900						
1050	Mod. orange (5YR6/8)	5	5.0	12.5	25.0	2.01
2000						
1100	Brownish orange (2.5YR5/8)	7	5.0	7.1	15.7	2.20
2100						
1150	Mod. reddish brown (10R3/4)	7	10.0	0.7	1.7	2.40
2200						
1200	---	---	Melted	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Vitrification between 1150 and 1200°C.

POTENTIAL USES: Facing brick at 1000-1100°C.

PERRY COUNTY

NORTHEAST MADISON TOWNSHIP

ANDERSONBURG QUADRANGLE

SAMPLE NUMBER 127-C-8

LOCATION: Exposure along the south side of Pa. Route 274, about 600 feet (180 m) south-west of Fort Robertson.

LATITUDE: 40°21'32"N

LONGITUDE: 77°23'02"W

GEOLOGIC UNIT: Bloomsburg Formation, Silurian

DESCRIPTION: Grayish-red (5R4/2), interbedded, thin-bedded shale and silty shale occur for intervals up to 10 feet (3 m) between sandstone and siltstone in the Bloomsburg Formation at this site. The shale beds range in thickness from about 1 to 4 inches (3 to 10 cm). The shale breaks to form hackly fragments.

ATTITUDE OF BEDDING: N67E, 33NW

WEATHERING INTENSITY: Slight

SAMPLED INTERVAL: Channel sample through 10 feet (3 m) of stratigraphic section of shale

CHEMICAL ANALYSIS:

	%
SiO ₂	~74
Al ₂ O ₃	13.90
Σ"Fe ₂ O ₃ ".....	6.69
MgO.....	1.05
CaO.....	0.46
Na ₂ O.....	0.65
K ₂ O.....	3.07
TiO ₂	1.07
MnO.....	0.038
Total ~100.93	

MINERALOGY (X-RAY):

	Weight %
Quartz	40
Mica-smectite	57
Kaolinite	0
Chlorite-vermiculite	1
Feldspar	2
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 15.0
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Fair
 pH: 7.1

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800	Grayish reddish orange (2.5YR5/6)	3	2.5	11.4	23.5	2.06
1000						
1900	Grayish reddish orange (2.5YR5/6)	4	5.0	11.3	23.2	2.05
1050						
2000	Strong brown (2.5YR4/6)	5	5.0	8.8	18.9	2.15
1100						
2100	Mod. reddish brown (2.5YR3/4)	6	7.5	2.8	6.4	2.28
1150						
2200	---	---	Melted	---	---	---
1200						
2300	---	---	---	---	---	---
1250						

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Vitrification between 1100 and 1150°C.

POTENTIAL USES: Facing brick at 1000-1100°C.

PERRY COUNTY

TUSCARORA TOWNSHIP

MILLERSTOWN QUADRANGLE

SAMPLE NUMBER 136-C-21

LOCATION: Shale pit along the southwest side of the medium-duty road that is southwest of and parallels the Juniata River southwest of Millerstown. The pit is located about 0.3 mile (495 m) southeast of the point where the medium-duty road intersects Pa. Route 17.

LATITUDE: 40°32'38"N

LONGITUDE: 77°09'27"W

GEOLOGIC UNIT: Mahantango Formation, Devonian

DESCRIPTION: Grayish-black (N2) to black (N1), very thin bedded, slightly silty shale is exposed in this shale pit. The shale breaks to form predominantly platy fragments. A moderate amount of iron staining is present along fractures and bedding planes.

ATTITUDE OF BEDDING: N87W, 48NE

WEATHERING INTENSITY: Moderate

SAMPLED INTERVAL: Channel sample through 10 feet (3 m) of stratigraphic section

CHEMICAL ANALYSIS:

	%
SiO ₂	67.2
Al ₂ O ₃	15.15
Σ"Fe ₂ O ₃ ".....	5.96
MgO.....	0.87
CaO.....	0.12
Na ₂ O.....	0.48
K ₂ O.....	3.52
TiO ₂	0.85
MnO.....	0.011
Total	94.16

MINERALOGY (X-RAY):

	Weight %
Quartz	31
Mica-smectite	67
Kaolinite	0
Chlorite-vermiculite	0
Feldspar	2
Calcite	0

RAW PROPERTIES:

Water of plasticity (%):	16.0
Drying shrinkage (%):	0.0
Workability:	Short
Dry strength:	Good
pH:	5.7

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800	Light brown to mod. orange					
1000	(5YR6/6)	4	5.0	15.8	29.9	1.89
1900	Light brown to mod. orange					
1050	(5YR6/6)	5	5.0	13.9	26.7	1.93
2000	Brownish orange (2.5YR5/8)	5	5.0	9.8	20.3	2.06
2100	Mod. reddish brown					
1150	(2.5YR3/4)	6	10.0	3.6	8.1	2.24
2200						
1200	---	---	Melted	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: ND

BLOATING TEST: Negative

REMARKS: Vitrification between 1100 and 1150°C.

POTENTIAL USES: Facing brick at 1000-1100°C.

PERRY COUNTY

TUSCARORA TOWNSHIP

MILLERSTOWN QUADRANGLE

SAMPLE NUMBER 136-C-22

LOCATION: Exposure in a shale pit on the northwest corner of the intersection of two light-duty roads near the southeast corner of Raccoon Ridge on the southwest side of the Juniata River.

LATITUDE: 40°32'18"N

LONGITUDE: 77°09'09"W

GEOLOGIC UNIT: Sherman Ridge Member, Mahantango Formation, Devonian

DESCRIPTION: Grayish-black (N2) to black (N1), very thin to thin-bedded shale is exposed in a pit that measures approximately 300 by 100 by 50 feet (90 by 30 by 15 m). The upper section of shale contains "clay balls" which measure up to about 3.3 feet (1.0 m) in long dimension. The shale breaks to form predominantly platy fragments.

ATTITUDE OF BEDDING: N70E, 58SE

WEATHERING INTENSITY: Slight to moderate

SAMPLE INTERVAL: Grab sample from fragments in pit

CHEMICAL ANALYSIS:

	%
SiO ₂	56.8
Al ₂ O ₃	18.75
Σ"Fe ₂ O ₃ ".....	6.26
MgO.....	1.74
CaO.....	1.55
Na ₂ O.....	0.71
K ₂ O.....	4.17
TiO ₂	0.90
MnO.....	0.052
Total	90.93

MINERALOGY (X-RAY):

	Weight %
Quartz	21
Mica-smectite	69
Kaolinite	0
Chlorite-vermiculite	6
Feldspar	3
Calcite	1

RAW PROPERTIES:

Water of plasticity (%):	11.4
Drying shrinkage (%):	0.0
Workability:	Short
Dry strength:	Good
pH:	6.7

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800	Brownish orange					
1000	(2.5YR5/8)	4	2.5	9.7	20.4	2.11
1900	Brownish orange					
1050	(2.5YR5/8)	4	2.5	8.3	18.0	2.16
2000	Strong brown					
1100	(2.5YR5/6)	5	5.0	4.0	9.2	2.29
2100						
1150	---	---	Expanded	---	---	---
2200						
1200	---	---	---	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Positive

REMARKS: ---

BLOATING TEST (QUICK-FIRING):

Temp. (°F) (°C)	Bulk density ³ (g/cc) (lb/ft ³)		% Absorb.	Remarks
1800 1000	2.08	130.0	6.2	No expansion.
1900 1050	1.79	111.8	9.1	Slight expansion.
2000 1100	1.64	102.5	9.9	Slight expansion.
2100 1150	1.05	65.6	12.4	Overfired; sticky.
2200 1200	--	--	--	--
2300 1250	--	--	--	--

REMARKS: Not suitable as lightweight aggregate (too heavy). May be limy.

POTENTIAL USES: Facing brick at 1100-1150°C.

PERRY COUNTY

CARROLL TOWNSHIP

NEWPORT QUADRANGLE

SAMPLE NUMBER 137-A-6

LOCATION: Shale pit operated by Kitner Bros. Excavating and Paving, Shermans Dale, Pennsylvania. Pit is located about 0.35 mile (560 m) southwest of Mecks Corner.

LATITUDE: 40°22'56"N

LONGITUDE: 77°08'51"W

GEOLOGIC UNIT: Sherman Ridge Member, Mahantango Formation, Devonian

DESCRIPTION: Moderate-olive-brown (5Y4/4) to moderate-yellowish-brown (10YR5/4), thickly laminated to thin-bedded shale is exposed in the pit. Beds range in thickness from $\frac{1}{4}$ to 3 inches (0.6 to about 8 cm). The shale breaks to form splintery, platy, or slabby fragments. A minor amount of iron staining is present along fractures and bedding planes.

ATTITUDE OF BEDDING: N60E, 25SE

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Channel sample through 13 feet (4 m) of stratigraphic section of shale collected at the top of the pit.

CHEMICAL ANALYSIS:

MINERALOGY (X-RAY):

	%
SiO ₂	59.4
Al ₂ O ₃	19.80
Σ"Fe ₂ O ₃ ".....	6.86
MgO.....	1.19
CaO.....	0.10
Na ₂ O.....	0.22
K ₂ O.....	4.15
TiO ₂	1.03
MnO.....	0.044
Total	92.79

	Weight %
Quartz	22
Mica-smectite	65
Kaolinite	10
Chlorite-vermiculite	2
Feldspar	1
Calcite	0

RAW PROPERTIES:

Water of plasticity (%):	15.6
Drying shrinkage (%):	0.0
Workability:	Short
Dry strength:	Good
pH:	6.4

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800 1000	Mod. orange (5YR6/8)	5	5.0	10.6	22.1	2.08
1900 1050	Mod. orange (5YR6/8)	5	5.0	9.0	19.3	2.14
2000 1100	Strong brown (2.5YR4/6)	6	7.5	3.6	8.6	2.36
2100 1150	Mod. reddish brown (2.5YR3/4)	6	10.0	0.5	1.3	2.42
2200 1200	---	---	Melted	---	---	---
2300 1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Vitrification between 1100 and 1200°C.

POTENTIAL USES: Facing brick, roofing tile at 1000-1100°C.

PERRY COUNTY

OLIVER TOWNSHIP

NEWPORT QUADRANGLE

SAMPLE NUMBER 137-A-7

LOCATION: Small exposure along the north side of the light-duty road that leads to Little Buffalo State Park, about 0.25 mile (400 m) west-northwest of that road's intersection with Pa. Route 34 in the vicinity of Buffalo Bridge.

LATITUOE: 40°27'56"N

LONGITUOE: 77°08'32"W

GEOLOGIC UNIT: Sherman Ridge Member, Mahantango Formation, Oevonian

DESCRIPTION: Grayish-olive (10Y4/2), very thin to medium-bedded shale is exposed in a 10-foot- (3-m-) high embankment along the road. The shale beds range in thickness from <½ to about 6 inches (<1 to about 15 cm). The shale breaks to form platy to flaggy fragments. Iron staining is common along fractures and bedding planes.

ATTITUOE OF BEDDING: N65E, 9NW

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Channel sample through 7.2 feet (2.2 m) of stratigraphic section

CHEMICAL ANALYSIS:		MINERALOGY (X-RAY):	
	%		Weight %
SiO ₂	65.2	Quartz	33
Al ₂ O ₃	16.00	Mica-smectite	51
Σ"Fe ₂ O ₃ ".....	5.48	Kaolinite	12
MgO.....	1.21	Chlorite-vermiculite	1
CaO.....	0.17	Feldspar	3
Na ₂ O.....	0.60	Calcite	0
K ₂ O.....	3.45		
TiO ₂	0.96		
MnO.....	0.039		
Total	93.11		

RAW PROPERTIES:
Water of plasticity (%): 15.2
Drying shrinkage (%): 0.0
Workability: Short
Dry strength: Good
pH: 6.4

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800	Brownish orange					
1000	(2.5YR5/8)	3	2.5	13.2	26.0	1.97
1900	Brownish orange					
1050	(2.5YR5/8)	4	5.0	12.2	24.5	2.01
2000	Strong brown					
1100	(2.5YR4/8)	5	5.0	7.8	16.9	2.17
2100	Mod. reddish brown					
1150	(2.5YR3/4)	7	10.0	3.8	8.6	2.29
2200	Mod. reddish brown					
1200	(10R3/4)	7	10.0	1.4	3.2	2.29
2300						
1250	---	---	Melted	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Vitrification between 1150 and 1250°C.

POTENTIAL USES: Facing brick at 1050-1200°C.

PERRY COUNTY

CENTRE TOWNSHIP

NEWPORT QUADRANGLE

SAMPLE NUMBER 137-A-8A

LOCATION: Inactive shale pit on the northwest side of a light-duty road, about 300 feet (90 m) southwest of that road's intersection with Pa. Route 34. The road distance from the center of New Bloomfield along Pa. Route 34 to this intersection measures about 0.8 mile (1.3 km).

LATITUDE: 40°24'49"N

LONGITUDE: 77°10'42"W

GEOLOGIC UNIT: Sherman Ridge Member, Mahantango Formation, Devonian

DESCRIPTION: Moderate-olive-brown (5Y4/4) to olive-gray (5Y3/2), thin to medium-bedded shale is exposed in this pit, which measures approximately 100 by 50 by 25 feet (30 by 15 by 8 m). The beds range in thickness from about 1 to 6 inches (3 to 15 cm). The shale breaks to form platy to flaggy fragments. A moderate amount of iron staining occurs along fractures and bedding planes.

ATTITUDE OF BEDDING: N58E, 82NW

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Channel sample through 8.2 feet (2.5 m) of stratigraphic section

CHEMICAL ANALYSIS:

	%
SiO ₂	66.7
Al ₂ O ₃	16.30
Σ"Fe ₂ O ₃ ".....	6.78
MgO.....	1.42
CaO.....	0.43
Na ₂ O.....	0.54
K ₂ O.....	3.26
TiO ₂	0.98
MnO.....	0.075
Total	96.48

MINERALOGY (X-RAY):

	Weight %
Quartz	33
Mica-smectite	57
Kaolinite	5
Chlorite-vermiculite	2
Feldspar	3
Calcite	0

RAW PROPERTIES:

Water of plasticity (%):	12.2
Drying shrinkage (%):	2.5
Workability:	Short
Dry strength:	Fair
pH:	7.2

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800	Brownish orange					
1000	(2.5YR5/8)	3	2.5	11.3	22.9	2.01
1900	Strong brown					
1050	(2.5YR4/8)	4	5.0	11.2	22.8	2.04
2000	Strong brown					
1100	(2.5YR4/6)	5	7.5	8.1	17.6	2.16
2100	Mod. reddish brown					
1150	(2.5YR3/4)	7	7.5	3.6	8.3	2.19
2200	Mod. reddish brown					
1200	(10R3/4)	7	7.5	1.7	3.7	2.27
2300						
1250	---	---	Melted	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Positive

REMARKS: ---

BLOATING TEST (QUICK-FIRING):

Temp. (°F) (°C)	Bulk density ³ (g/cc) (lb/ft ³)		% Absorb.	Remarks
1800 1000	2.25	140.5	4.6	No expansion.
1900 1050	1.81	113.1	8.5	Slight expansion.
2000 1100	1.27	79.2	7.3	Some large pores.
2100 1150	1.03	64.3	7.7	Overfired.
2200 1200	--	--	--	--
2300 1250	--	--	--	--

REMARKS: Too heavy for lightweight aggregate.

POTENTIAL USES: Facing brick at 1050-1200°C.

PERRY COUNTY

CENTRE TOWNSHIP

NEWPORT QUADRANGLE

SAMPLE NUMBER 137-A-8B

LOCATION: Inactive shale pit on the northwest side of a light-duty road about 300 feet (90 m) southwest of this road's intersection with Pa. Route 34. The road distance from the center of New Bloomfield along Route 34 to this intersection is about 0.8 mile (1.3 km).

LATITUDE: 40°24'49"N

LONGITUDE: 77°10'42"W

GEOLOGIC UNIT: Sherman Ridge Member, Mahantango Formation, Devonian

DESCRIPTION: Grayish-olive (10Y4/2) to olive-gray (5Y3/2), thin- to medium-bedded shale and silty shale occur stratigraphically below sample 137-A-8A. The shale breaks to form hackly or rubbly fragments, whereas the silty shale tends to break into blocky fragments. A moderate amount of iron staining occurs along fractures and bedding planes in the shales.

ATTITUDE OF BEDDING: N58E, 82NW

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Channel sample through 7 feet (2.1 m) of shale

CHEMICAL ANALYSIS:

	%
SiO ₂	66.6
Al ₂ O ₃	16.45
Σ"Fe ₂ O ₃ ".....	6.82
MgO.....	1.36
CaO.....	0.23
Na ₂ O.....	0.52
K ₂ O.....	3.20
TiO ₂	1.02
MnO.....	0.076
Total	96.28

MINERALOGY (X-RAY):

	Weight %
Quartz	29
Mica-smectite	63
Kaolinite	4
Chlorite-vermiculite	1
Feldspar	3
Calcite	0

RAW PROPERTIES:

Water of plasticity (%):	14.6
Drying shrinkage (%):	2.5
Workability:	Short
Dry strength:	Fair
pH:	7.1

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (5YR6/8)	3	5.0	13.3	20.6	1.95
1900						
1050	Brownish orange (2.5YR5/8)	3	5.0	12.5	24.9	1.99
2000						
1100	Strong brown (2.5YR4/6)	5	7.5	9.4	19.7	2.11
2100						
1150	Mod. reddish brown (2.5YR3/4)	6	7.5	5.0	11.0	2.18
2200						
1200	Mod. reddish brown (10R3/4)	7	7.5	2.6	5.6	2.20
2300						
1250	---	---	Melted	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Vitrification between 1200 and 1250°C.

POTENTIAL USES: Facing brick at 1100-1200°C.

PERRY COUNTY

CENTRE TOWNSHIP

NEWPORT QUADRANGLE

SAMPLE NUMBER 137-A-11

LOCATION: Inactive shale pit on the north side of a light-duty road about 1,000 feet (300 m) east-southeast of the road's intersection with Pa. Route 34. The road distance from the center of New Bloomfield along Route 34 to this intersection is 0.7 mile (1,120 m).

LATITUDE: 40°24'55"N

LONGITUDE: 77°10'29"W

GEOLOGIC UNIT: Sherman Ridge Member, Mahantango Formation, Devonian

DESCRIPTION: Light-olive-gray (5Y5/2), thin- to medium-bedded shale is exposed in this pit, which measures approximately 250 by 100 by 50 feet (75 by 30 by 15 m). The beds range in thickness from about 1.5 to 12 inches (4 to 30 cm). The shale commonly breaks to form platy to hackly fragments; minor amounts of flaggy and rubbly fragments are also present. Iron staining in moderate amounts is present along fractures and bedding planes.

ATTITUDE OF BEDDING: N60E, 74NW

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Channel sample through 36 feet (11 m) of shale

CHEMICAL ANALYSIS:

MINERALOGY (X-RAY):

	%
SiO ₂	64.5
Al ₂ O ₃	16.80
Σ"Fe ₂ O ₃ ".....	6.38
MgO.....	1.26
CaO.....	0.22
Na ₂ O.....	0.43
K ₂ O.....	3.42
TiO ₂	0.99
MnO.....	0.049
Total	94.05

	Weight %
Quartz	23
Mica-smectite	73
Kaolinite	0
Chlorite-vermiculite	2
Feldspar	2
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 15.6
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Fair
 pH: 6.7

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800 1000	Brownish to deep orange (2.5YR5/10)	3	5.0	13.1	25.9	1.98
1900 1050	Brownish orange (2.5YR5/8)	4	5.0	11.8	23.8	2.01
2000 1100	Strong brown (2.5YR4/8)	5	7.5	8.0	17.3	2.17
2100 1150	Mod. reddish brown (2.5YR3/4)	6	10.0	3.9	8.7	2.24
2200 1200	Mod. reddish brown (10R3/4)	7	10.0	2.2	4.9	2.26
2300 1250	---	---	Melted	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Vittrification between 1200 and 1250°C.

POTENTIAL USES: Facing brick at 1050-1200°C.

PERRY COUNTY

CENTRE TOWNSHIP

DUNCANNON QUADRANGLE

SAMPLE NUMBER 137-B-12

LOCATION: Exposure along the north side of a light-duty road that is north of Little Juniata Creek and approximately 4 miles (6.4 km) east-northeast of New Bloomfield.

LATITUDE: 40°25'47"N

LONGITUDE: 77°07'09"W

GEOLOGIC UNIT: Trimmers Rock and Brallier Formations (undivided), Devonian

DESCRIPTION: Light-olive-gray (5Y5/2) to olive-gray (5Y3/2), thin-bedded and interbedded shaly siltstone and silty shale are exposed along the north side of the road. Siltstone makes up about 50 percent of the exposure. The siltstone and silty shale commonly break to form platy to flaggy fragments; a few blocky fragments are also present. The frequency of joints ranges from about 3 to 12 inches (8 to 30 cm). A minor amount of iron staining is present along fractures and bedding planes.

ATTITUDE OF BEDDING: N64E, 63SE

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Channel sample through 25 feet (8 m) of stratigraphic section

CHEMICAL ANALYSIS:

	%
SiO ₂	65.3
Al ₂ O ₃	15.15
Σ"Fe ₂ O ₃ ".....	6.34
MgO.....	1.31
CaO.....	0.18
Na ₂ O.....	0.62
K ₂ O.....	2.97
TiO ₂	0.94
MnO.....	0.036
Total	92.85

MINERALOGY (X-RAY):

	Weight %
Quartz	27
Mica-smectite	67
Kaolinite	0
Chlorite-vermiculite	5
Feldspar	1
Calcite	0

RAW PROPERTIES:

Water of plasticity (%):	14.4
Drying shrinkage (%):	0.0
Workability:	Short
Dry strength:	Fair
pH:	7.0

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800	Brownish to deep orange					
1000	(2.5YR5/10)	3	2.5	12.8	25.4	1.98
1900	Brownish orange					
1050	(2.5YR5/8)	3	2.5	12.4	24.7	2.00
2000	Strong brown (2.5YR4/8)	5	5.0	9.0	19.1	2.12
2100	Mod. reddish brown					
1150	(2.5YR3/4)	6	5.0	4.5	10.2	2.25
2200	Mod. reddish brown					
1200	(10R3/4)	7	7.5	2.0	4.6	2.29
2300	---	---	Melted	---	---	---
1250						

PYROMETRIC CONE EQUIVALENT: ND

BLOATING TEST: Negative

REMARKS: Vitrification between 1200 and 1250°C.

POTENTIAL USES: Facing brick at 1100-1200°C.

PERRY COUNTY

WATTS TOWNSHIP

DUNCANNON QUADRANGLE

SAMPLE NUMBER 137-B-13

LOCATION: Exposure on the east side of the Watts exit from U. S. Route 22-322, about 180 feet (55 m) southeast of the stream channel.

LATITUDE: 40°26'58"N

LONGITUDE: 77°01'11"W

GEOLOGIC UNIT: Irish Valley Member, Catskill Formation, Devonian

DESCRIPTION: Grayish-red (10R4/2) to very dusky red (10R2/2), thin-bedded silty shale is exposed along the road. The beds range in thickness from 1 to 4 inches (3 to 10 cm). The shale breaks to form splintery to platy fragments. Joints are spaced from 4 to 7 inches (10 to 18 cm) apart. A minor amount of iron staining is present along fractures and bedding planes. The sample was collected directly below a 42-inch (108-cm) interval of sandstone.

ATTITUDE OF BEDDING: N57E, 45SE

WEATHERING INTENSITY: Slight

SAMPLED INTERVAL: Composite representing 15 feet (5 m) of stratigraphic section

CHEMICAL ANALYSIS:

	%
SiO ₂	64.3
Al ₂ O ₃	18.25
Σ"Fe ₂ O ₃ ".....	7.26
MgO.....	1.73
CaO.....	0.26
Na ₂ O.....	0.68
K ₂ O.....	3.54
TiO ₂	0.98
MnO.....	0.071
Total	97.07

MINERALOGY (X-RAY):

	Weight %
Quartz	24
Mica-smectite	69
Kaolinite	0
Chlorite-vermiculite	5
Feldspar	2
Calcite	0

RAW PROPERTIES:

Water of plasticity (%):	14.0
Drying shrinkage (%):	2.5
Workability:	Short
Dry strength:	Fair
pH:	6.6

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Brownish orange (2.5YR5/8)	4	2.5	11.2	23.1	2.07
1900						
1050	Strong brown (2.5YR4/8)	5	2.5	10.4	21.6	2.09
2000						
1100	Strong brown (2.5YR4/6)	7	5.0	5.9	13.4	2.27
2100	Mod. reddish brown					
1150	(2.5YR3/4)	7	7.5	2.8	6.3	2.30
2200						
1200	---	---	Melted	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Vitrification between 1150 and 1200°C.

POTENTIAL USES: Facing brick at 1000-1150°C.

PERRY COUNTY

HOWE TOWNSHIP

DUNCANNON QUADRANGLE

SAMPLE NUMBER 137-B-14

LOCATION: Exposure along the northwest side of Pa. Route 34, about 700 feet (210 m) east-northeast of Red Hill Church.

LATITUDE: 40°29'31"N

LONGITUDE: 77°06'51"W

GEOLOGIC UNIT: Irish Valley Member, Catskill Formation, Devonian

DESCRIPTION: Grayish-red (10R4/2), thin-bedded silty shale is interbedded with intervals of sandstone and siltstone in this exposure. The greatest interval of shale measured 15 feet (5 m) and constitutes the material in this sample. The shale breaks to form predominantly platy fragments. Mica is scattered through the shale. Joints are spaced from about 5 to 14 inches (13 to 36 cm) apart.

ATTITUDE OF BEDDING: N67E, 52NW

WEATHERING INTENSITY: Slight to moderate

SAMPLE INTERVAL: Channel sample through 15 feet (5 m) of continuous shale in this stratigraphic section

CHEMICAL ANALYSIS:

	%
SiO ₂	66.7
Al ₂ O ₃	14.55
Σ"Fe ₂ O ₃ ".....	6.76
MgO.....	1.43
CaO.....	0.26
Na ₂ O.....	0.76
K ₂ O.....	3.42
TiO ₂	0.98
MnO.....	0.046
Total	94.91

MINERALOGY (X-RAY):

	Weight %
Quartz	25
Mica-smectite	67
Kaolinite	2
Chlorite-vermiculite	3
Feldspar	3
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 12.0
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Good
 pH: 6.9

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Strong brown (2.5YR4/8)	5	2.5	10.6	22.1	2.09
1900						
1050	Strong brown (2.5YR4/8)	5	2.5	8.8	18.9	2.14
2000						
1100	Strong brown (2.5YR4/6)	7	5.0	4.6	10.6	2.32
2100						
1150	Mod. reddish brown (2.5YR3/4)	7	7.5	1.5	3.6	2.32
2200						
1200	---	---	Melted	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Vitrification between 1150 and 1200°C.

POTENTIAL USES: Facing brick at 1000-1150°C.

PERRY COUNTY

WATTS TOWNSHIP

DUNCANNON QUADRANGLE

SAMPLE NUMBER 137-B-15

LOCATION: Exposure along the northeast side of the Watts entrance ramp to U. S. Route 22-322.

LATITUDE: 40°27'03"N

LONGITUDE: 77°01'15"W

GEOLOGIC UNIT: Trimmers Rock and Brallier Formations (undivided), Devonian

DESCRIPTION: Light-olive-gray (5Y5/2), thin-bedded silty shale occurs for a stratigraphic interval of 20 feet (6 m). The beds range in thickness from 1 to 4 inches (3 to 10 cm). The silty shale breaks to form predominantly platy to flaggy fragments and some splintery fragments. Iron staining is present in moderate amounts along fractures and bedding planes.

ATTITUDE OF BEDDING: N55E, 45SE

WEATHERING INTENSITY: Slight

SAMPLE INTERVAL: Channel sample through 15 feet (5 m) of stratigraphic section

CHEMICAL ANALYSIS:

	%
SiO ₂	62.6
Al ₂ O ₃	17.50
Σ"Fe ₂ O ₃ ".....	6.67
MgO.....	1.50
CaO.....	0.07
Na ₂ O.....	0.59
K ₂ O.....	3.63
TiO ₂	0.96
MnO.....	0.033
Total	93.55

MINERALOGY (X-RAY):

	Weight %
Quartz	22
Mica-smectite	72
Kaolinite	1
Chlorite-vermiculite	3
Feldspar	2
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 14.8
 Drying shrinkage (%): 0.0
 Workability: Short
 Dry strength: Fair
 pH: 6.8

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800	Brownish to deep orange (2.5YR5/10)	3	2.5	10.9	22.7	2.08
1900	Brownish orange (2.5YR5/8)	5	5.0	8.8	18.9	2.16
2000	Strong brown (2.5YR4/6)	6	5.0	3.9	9.2	2.36
2100	Mod. reddish brown (2.5YR3/4)	7	7.5	0.9	2.1	2.40
2200	---	---	Melted	---	---	---
1200	---	---	---	---	---	---
2300	---	---	---	---	---	---
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: ND

BLOATING TEST: Negative

REMARKS: Vitrification between 1150 and 1200°C.

POTENTIAL USES: Facing brick at 1050-1150°C.

PERRY COUNTY

CARROLL TOWNSHIP

SHERMANS DALE QUADRANGLE

SAMPLE NUMBER 137-C-9

LOCATION: Exposure along the east side of Pa. Route 34 (identified as Pa. Route 850 on the 1973 edition of the Shermans Dale 7½-minute topographic sheet), about 0.65 mile (1,040 m) northwest of Shermans Dale.

LATITUDE: 40°19'50"N

LONGITUDE: 77°10'53"W

GEOLOGIC UNIT: Catskill Formation, Devonian

DESCRIPTION: Grayish-red (10Y4/2), thin-bedded shale occurs between sandstone units of the Catskill Formation in this exposure. The shale interval measures 8.5 feet (2.6 m). The shale breaks to form hackly to platy fragments. Joints of the same set occur from 9 to 14 inches (23 to 36 cm) apart.

ATTITUDE OF BEDDING: N10E, 13SE

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Channel sample through 8.5 feet (2.6 m) of stratigraphic section of shale

CHEMICAL ANALYSIS:

	%
SiO ₂	66.1
Al ₂ O ₃	15.95
Σ"Fe ₂ O ₃ ".....	8.11
MgO.....	1.53
CaO.....	0.22
Na ₂ O.....	0.88
K ₂ O.....	3.66
TiO ₂	1.09
MnO.....	0.032
Total	97.57

MINERALOGY (X-RAY):

	Weight %
Quartz	27
Mica-smectite	67
Kaolinite	0
Chlorite-vermiculite	2
Feldspar	4
Calcite	0

RAW PROPERTIES:

Water of plasticity (%)	15.0
Drying shrinkage (%)	0.0
Workability:	Short
Dry strength:	Good
pH:	6.9

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Strong brown (2.5YR4/8)	5	2.5	10.2	21.5	2.11
1900						
1050	Strong brown (2.5YR4/6)	5	2.5	9.1	19.6	2.15
2000						
1100	Mod. reddish brown (2.5YR4/4)	6	5.0	3.3	8.0	2.31
2100						
1150	Mod. reddish brown (10R3/4)	7	7.5	0.8	1.9	2.39
2200						
1200	---	---	Melted	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Vitrification between 1150 and 1200°C.

POTENTIAL USES: Facing brick at 1000-1150°C.

PERRY COUNTY

CARROLL TOWNSHIP

SHERMANS DALE QUADRANGLE

SAMPLE NUMBER 137-C-10A

LOCATION: Exposure along the northeast side of Pa. Route 34, about 0.4 mile (640 m) southeast of Oromgold.

LATITUDE: 40°20'28"N

LONGITUDE: 77°11'13"W

GEOLOGIC UNIT: Trimmers Rock and Brallier Formations (undivided), Devonian

DESCRIPTION: Olive-gray (5Y3/2), thin-bedded and interbedded shaly siltstone and silty shale are exposed in a 10- to 15-foot- (3- to 5-m-) high roadcut. The silty shale breaks to form platy fragments, whereas the shaly siltstone forms slabby to blocky fragments. Joints are spaced from 6 to 10 inches (15 to 26 cm) apart.

ATTITUDE OF BEDDING: N65E, 29SE

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Channel sample through 11 feet (3 m) of stratigraphic section

CHEMICAL ANALYSIS:

	%
SiO ₂	~72
Al ₂ O ₃	13.45
Σ"Fe ₂ O ₃ ".....	5.75
MgO.....	1.07
CaO.....	0.14
Na ₂ O.....	0.69
K ₂ O.....	2.57
TiO ₂	0.99
MnO.....	0.039
Total	~96.70

MINERALOGY (X-RAY):

	Weight %
Quartz	46
Mica-smectite	45
Kaolinite	0
Chlorite-vermiculite	6
Feldspar	3
Calcite	0

RAW PROPERTIES:

Water of plasticity (%):	15.0
Drying shrinkage (%):	2.5
Workability:	Short
Dry strength:	Fair
pH:	7.0

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800	Brownish orange					
1000	(2.5YR5/8)	3	2.5	15.5	29.9	1.83
1900	Brownish orange					
1050	(2.5YR5/8)	3	2.5	16.8	30.8	1.92
2000	Strong brown					
1100	(2.5YR4/6)	5	5.0	10.4	21.4	2.07
2100	Mod. reddish brown					
1150	(2.5YR3/4)	7	7.5	6.9	14.8	2.15
2200	Mod. reddish brown					
1200	(10R3/4)	7	7.5	1.3	3.0	2.31
2300	---	---	Melted	---	---	---
1250	---	---				

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Vitrification between 1200 and 1250°C.

POTENTIAL USES: Facing brick at 1100-1200°C.

PERRY COUNTY

CARROLL TOWNSHIP

SHERMANS DALE QUADRANGLE

SAMPLE NUMBER 137-C-10B

LOCATION: Exposure along the northeast side of Pa. Route 34 about 0.4 mile (640 m) southeast of Oromgold.

LATITUDE: 40°20'28"N

LONGITUDE: 77°11'13"W

GEOLOGIC UNIT: Trimmers Rock and Brallier Formations (undivided), Devonian

DESCRIPTION: Olive-gray (5Y3/2), thin-bedded and interbedded shaly siltstone and silty shale occur stratigraphically below sample 137-C-10A. The silty shale breaks to form platy fragments, whereas the shaly siltstone forms slabby to blocky fragments. Joints are spaced from 6 to 10 inches (15 to 26 cm) apart.

ATTITUDE OF BEDDING: N65E, 29SE

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Channel sample through 10.5 feet (3.2 m) of stratigraphic section

CHEMICAL ANALYSIS:

	%
SiO ₂	68.7
Al ₂ O ₃	14.50
Σ"Fe ₂ O ₃ ".....	6.31
MgO.....	1.38
CaO.....	0.24
Na ₂ O.....	0.87
K ₂ O.....	2.82
TiO ₂	0.96
MnO.....	0.051
Total	95.83

MINERALOGY (X-RAY):

	Weight %
Quartz	32
Mica-smectite	56
Kaolinite	4
Chlorite-vermiculite	4
Feldspar	4
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 13.0
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Good
 pH: 7.0

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800	Brownish orange					
1000	(2.5YR5/8)	4	2.5	13.7	27.0	1.97
1900	Strong brown					
1050	(2.5YR4/8)	5	2.5	12.1	24.4	2.02
2000	Strong brown					
1100	(2.5YR4/6)	5	7.5	7.9	17.2	2.18
2100	Mod. reddish brown					
1150	(2.5YR3/4)	7	7.5	3.3	7.6	2.20.
2200	Mod. reddish brown					
1200	(10R3/4)	7	7.5	1.2	2.6	2.30
2300						
1250	---	---	Melted	---	---	---

PYROMETRIC CONE EQUIVALENT: ND

BLOATING TEST: Negative

REMARKS: Vitrification between 1200 and 1250°C.

POTENTIAL USES: Facing brick at 1000-1200°C.

SNYDER COUNTY

SPRING TOWNSHIP

BEAVERTOWN QUADRANGLE

SAMPLE NUMBER 135-C-6

LOCATION: Shale pit operated by Rudolph R. Ewing located about 1.60 miles (2.60 km) west of the village of Benfer.

LATITUDE: 40°46'11"N

LONGITUDE: 77°14'22"W

GEOLOGIC UNIT: Harrell Formation, Devonian

DESCRIPTION: Moderate-olive-brown (5Y4/4) to dark-yellowish-brown (10YR4/2) chips and platy particles of shale occur as an unconsolidated deposit at this location. Some of the particles are subrounded, suggesting abrasion during transport by gravity (downhill creep) or water action after intense weathering of the parent material. The pit is estimated to be 50 feet (15 m) deep.

ATTITUDE OF BEDDING: Essentially horizontal

WEATHERING INTENSITY: Severe to moderate

SAMPLED INTERVAL: Channel through 10 stratigraphic feet (3 m)

CHEMICAL ANALYSIS:

MINERALOGY (X-RAY):

	%
SiO ₂	62.2
Al ₂ O ₃	17.65
Σ"Fe ₂ O ₃ ".....	6.97
MgO.....	1.45
CaO.....	0.17
Na ₂ O.....	0.57
K ₂ O.....	3.66
TiO ₂	0.97
MnO.....	0.070
Total	93.71

	Weight %
Quartz	19
Mica-smectite	74
Kaolinite	0
Chlorite-vermiculite	5
Feldspar	2
Calcite	0

RAW PROPERTIES:

Water of plasticity (%):	17.5
Drying shrinkage (%):	2.5
Workability:	Short
Dry strength:	Fair
pH:	6.8

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800	Mod. orange					
1000	(2.5YR6/8)	3	2.5	13.3	26.1	1.96
1900	Brownish orange					
1050	(2.5YR5/8)	4	5.0	9.8	20.3	2.08
2000	Grayish reddish orange					
1100	(2.5YR5/6)	4	7.5	5.9	13.0	2.22
2100	Mod. reddish brown					
1150	(2.5YR4/4)	5	7.5	1.8	4.3	2.35
2200						
1200	---	---	Melted	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: ND

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Structural clay products (e.g., building brick at 1050-1150°C).

SNYDER COUNTY

SPRING TOWNSHIP

BEAVERTOWN QUADRANGLE

SAMPLE NUMBER 135-C-7

LOCATION: Shale pit operated by Spring Township located about 1.4 miles (2.3 km) southwest of the village of Benfer.

LATITUDE: 40°45'39"N

LONGITUDE: 77°13'45"W

GEOLOGIC UNIT: Mahantango Formation, Devonian

DESCRIPTION: Light-gray (5Y3/2) shale of the Mahantango Formation occurs primarily as a group of ellipsoidal forms which range from 2 to 5 feet (0.6 to 1.5 m) in long dimension and have widths ranging from 2 to 4 feet (0.6 to 1.2 m) and heights from 2 to 3 feet (0.6 to 0.9 m). Concentric weathering is obvious. Iron and manganese staining occurs along fractures and partings.

ATTITUDE OF BEDDING: N70E(?), vertical dip

WEATHERING INTENSITY: Moderate to slight

SAMPLED INTERVAL: Channel through 12 stratigraphic feet (4 m)

CHEMICAL ANALYSIS:

	%
SiO ₂	67.2
Al ₂ O ₃	18.85
Σ ^{IV} Fe ₂ O ₃ ".....	6.14
MgO.....	1.40
CaO.....	0.23
Na ₂ O.....	0.63
K ₂ O.....	3.63
TiO ₂	0.89
MnO.....	0.045
Total	99.02

MINERALOGY (X-RAY):

	Weight %
Quartz	28
Mica-smectite	66
Kaolinite	0
Chlorite-vermiculite	3
Feldspar	3
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 20.9
 Drying shrinkage (%): 0.0
 Workability: Short
 Dry strength: Fair
 pH: 6.7

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (5YR6/8)	3	5.0	11.8	23.9	2.02
1900						
1050	Mod. orange (2.5YR6/8)	4	5.0	9.1	19.1	2.11
2000						
1100	Brownish orange (2.5YR5/8)	4	7.5	5.6	12.6	2.24
2100						
1150	Strong brown (2.5YR4/6)	5	7.5	2.2	5.1	2.34
2200						
1200	---	---	Melted	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Structural clay products (e.g., building brick at 1050-1150°C).

SNYDER COUNTY

FRANKLIN TOWNSHIP

MIDDLEBURG QUADRANGLE

SAMPLE NUMBER 135-D-8

LOCATION: Shale pit operated by Hackenburg Construction, Inc., located about 1 mile (1.6 km) west of the village of Kissimmee.

LATITUOE: 40°47'40"N

LONGITUOE: 77°06'16"W

GEOLOGIC UNIT: Devonian marine units

DESCRIPTION: Dark-greenish-gray (5GY4/1) to olive-gray (5Y4/1), thin- to medium-bedded silty shale and shaly siltstone are exposed in this pit. The beds range in thickness from about 2 to 6 inches (5 to 15 cm) and form slabby fragments when ripped out during excavation. The fragments commonly measure 1 to 2 feet (0.3 to 0.6 m) in long dimension.

ATTITUOE OF BEOOING: N81E, 44NW

WEATHERING INTENSITY: Moderate to slight

SAMPLED INTERVAL: Channel through 12 stratigraphic feet (4 m)

CHEMICAL ANALYSIS:		MINERALOGY (X-RAY):	
	%		Weight %
SiO ₂	65.3	Quartz	33
Al ₂ O ₃	15.25	Mica-smectite	60
Σ"Fe ₂ O ₃ ".....	6.09	Kaolinite	0
MgO.....	1.34	Chlorite-vermiculite	2
CaO.....	0.17	Feldspar	5
Na ₂ O.....	0.77	Calcite	0
K ₂ O.....	3.14	RAW PROPERTIES:	
TiO ₂	0.96		
MnO.....	0.070		
Total	93.09		
		Water of plasticity (%): 15.4	
		Drying shrinkage (%): 0.0	
		Workability: Short	
		Dry strength: Fair	
		pH: 6.8	

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800 1000	Mod. orange (2.5YR6/8)	3	2.5	14.3	27.8	1.94
1900 1050	Brownish orange (2.5YR5/8)	3	2.5	12.1	24.1	2.00
2000 1100	Strong brown (2.5YR4/8)	4	5.0	9.3	19.6	2.09
2100 1150	Mod. reddish brown (10R4/4)	4	5.0	4.9	10.9	2.25
2200 1200	Mod. reddish brown (10R3/4)	5	7.5	2.7	6.2	2.27
2300 1250	---	---	Melted	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Structural clay products (e.g., building brick at 1100-1200°C).

SNYDER COUNTY

CENTER TOWNSHIP

MIDDLEBURG QUADRANGLE

SAMPLE NUMBER 135-D-9

LOCATION: Inactive shale pit under permit to Richards Excavating, located about 1.25 miles (2.00 km) on a bearing of about S35E from the village of Penns Creek.

LATITUDE: 40°50'33"N

LONGITUDE: 77°02'40"W

GEOLOGIC UNIT: Devonian marine units

DESCRIPTION: Light-olive-gray (5Y5/2) and moderate-olive-brown (5Y4/4), interbedded, very thin to thin-bedded shale and silty shale are exposed in this pit. The shale and silty shale form predominantly platy to flaggy fragments when broken. Sample was collected on the southeast corner of the pit, starting below a 30-inch (76-cm) bed of sandstone.

ATTITUDE OF BEDDING: N58E, 22SE

WEATHERING INTENSITY: Severe to moderate

SAMPLED INTERVAL: Channel through 10 stratigraphic feet (3 m)

CHEMICAL ANALYSIS:

	%
SiO ₂	60.5
Al ₂ O ₃	18.55
Σ"Fe ₂ O ₃ ".....	7.10
MgO.....	1.43
CaO.....	0.18
Na ₂ O.....	0.49
K ₂ O.....	4.00
TiO ₂	0.97
MnO.....	0.035
Total	93.26

MINERALOGY (X-RAY):

	Weight %
Quartz	21
Mica-smectite	75
Kaolinite	0
Chlorite-vermiculite	2
Feldspar	2
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 18.5
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Fair
 pH: 7.0

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800	Mod. to strong orange					
1000	(2.5YR6/10)	3	5.0	11.7	23.7	2.03
1900	Mod. orange (2.5YR6/8)	4	5.0	8.8	18.8	2.13
1050						
2000	Brownish orange					
1100	(2.5YR5/8)	4	7.5	5.1	11.7	2.28
2100						
1150	Strong brown (2.5YR4/6)	4	10.0	1.5	3.5	2.41
2200						
1200	---	---	Melted	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Structural clay products (e.g., building brick at 1050-1150°C).

SNYDER COUNTY

WEST PERRY TOWNSHIP

RICHFIELD QUADRANGLE

SAMPLE NUMBER 136-B-29

LOCATION: Quarry on the north side of a medium-duty road that follows the south flank of Florrey Ridge, about 1 mile (1.6 km) southeast of Richfield and about 0.3 mile (490 m) south-southeast of Pine Cemetery.

LATITUDE: 40°40'55"N

LONGITUDE: 77°05'43"W

GEOLOGIC UNIT: Sherman Ridge Member, Mahantango Formation, Oevonian

DESCRIPTION: Light-olive-gray (5Y5/2), thin-bedded silty shale is exposed in the quarry. The shale exhibits spheroidal exfoliation and breaks to form platy fragments. Some iron and manganese oxide staining is present along bedding planes and fracture surfaces.

ATTITUDE OF BEOOING: NE-SW, 52SE

WEATHERING INTENSITY: Moderate

SAMPLED INTERVAL: Composite representing 15 feet (5 m) of stratigraphic section at north end of quarry

CHEMICAL ANALYSIS:		MINERALOGY (X-RAY):	
	%		Weight %
SiO ₂	58.0	Quartz	22
Al ₂ O ₃	19.30	Mica-smectite	72
Σ"Fe ₂ O ₃ ".....	7.05	Kaolinite	0
MgO.....	1.67	Chlorite-vermiculite	3
CaO.....	0.15	Feldspar	3
Na ₂ O.....	0.48	Calcite	0
K ₂ O.....	4.32		
TiO ₂	0.97		
MnO.....	0.048		
Total 91.99			

RAW PROPERTIES:
Water of plasticity (%): 18.6
Orying shrinkage (%): 5.0
Workability: Short
Ory strength: Poor
pH: 7.1

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800	Mod. orange to strong orange (2.5YR6/10)	4	7.5	12.5	24.2	1.93
1000						
1900	Mod. orange to strong orange (2.5YR6/10)	5	10.0	10.4	20.9	2.02
1050						
2000	Strong brown (2.5YR4/8)	6	10.0	4.3	9.1	2.13
1100						
2100	Strong brown (2.5YR4/8)	7	10.0	2.7	5.2	2.19
1150						
2200	---	---	Expanded	---	---	---
1200						
2300	---	---	---	---	---	---
1250						

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Good firing range.

POTENTIAL USES: Building brick at 1000-1150°C.

SNYDER COUNTY

JACKSON TOWNSHIP

LEWISBURG QUADRANGLE

SAMPLE NUMBER 145-A-1

LOCATION: Shale pit being operated by Mahlon L. Boop located east of Penns Creek about 2.5 miles (4.0 km) east of the center of New Berlin.

LATITUDE: 40°52'47"N

LONGITUDE: 76°56'31"W

GEOLOGIC UNIT: Trimmers Rock Formation, Devonian

DESCRIPTION: Interbedded, thin-bedded shale, silty shale, and shaly siltstone are included in this stratigraphic interval, which was sampled in the north end of the pit. Thickness of the beds ranges from about 0.2 to 8.7 inches (0.5 to 22 cm). Unweathered rock is grayish olive (10Y4/2); weathered rock ranges from dusky yellow (5Y6/4) to pale olive (10Y6/2). The rock breaks to form platy to flaggy fragments. Iron staining is common along fractures and bedding planes.

ATTITUDE OF BEDDING: N75E, 55SE

WEATHERING INTENSITY: Moderate to severe

SAMPLED INTERVAL: Composite representing 15 feet (5 m) of stratigraphic section

CHEMICAL ANALYSIS:

MINERALOGY (X-RAY):

	%
SiO ₂	64.4
Al ₂ O ₃	17.35
Σ"Fe ₂ O ₃ ".....	6.13
MgO.....	1.03
CaO.....	0.05
Na ₂ O.....	0.24
K ₂ O.....	3.51
TiO ₂	0.98
MnO.....	0.044
Total	93.73

	Weight %
Quartz	26
Mica-smectite	70
Kaolinite	0
Chlorite-vermiculite	3
Feldspar	1
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 19.4
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Fair
 pH: 6.3

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (5YR7/6)	3	2.5	18.2	32.7	1.80
1900						
1050	Mod. orange (5YR6/8)	3	5.0	16.2	30.2	1.87
2000	Brownish orange (2.5YR5/8)	5	5.0	10.4	21.3	2.05
2100	Light reddish brown (10R5/4)	5	7.5	4.7	10.4	2.24
2200	Mod. reddish brown (10R4/4)	5	7.5	2.8	6.4	2.29
2300						
1250	---	---	Melted	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Structural clay products (e.g., building brick at 1100-1200°C).

SNYDER COUNTY

MIDDLECREEK TOWNSHIP

FREEBURG QUADRANGLE

SAMPLE NUMBER 145-C-3

LOCATION: Shale pit operated by M. J. Long located about 0.85 mile (1.4 km) south of Kreamer on the east side of a light-duty road.

LATITUDE: 40°47'28"N

LONGITUDE: 76°57'47"W

GEOLOGIC UNIT: Clinton Group, Silurian

DESCRIPTION: Yellow-gray (5Y7/2) to dusky-yellow (5Y6/4), thin-bedded silty shale interbedded with a few thin beds of siltstone occurs in this pit. The shale breaks to form predominantly platy fragments. Iron staining is common along fractures and bedding planes.

ATTITUDE OF BEDDING: N77W, 13NE

WEATHERING INTENSITY: Slight to moderate

SAMPLED INTERVAL: Channel through 12 feet (4 m) of stratigraphic section

CHEMICAL ANALYSIS:

	%
SiO ₂	59.3
Al ₂ O ₃	20.75
Σ"Fe ₂ O ₃ ".....	7.41
MgO.....	1.42
CaO.....	0.17
Na ₂ O.....	0.34
K ₂ O.....	4.86
TiO ₂	0.98
MnO.....	0.059
Total	95.29

MINERALOGY (X-RAY):

	Weight %
Quartz	14
Mica-smectite	77
Kaolinite	6
Chlorite-vermiculite	2
Feldspar	1
Calcite	0

RAW PROPERTIES:

Water of plasticity (%):	14.5
Drying shrinkage (%):	2.5
Workability:	Short
Dry strength:	Poor
pH:	7.2

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod orange (5YR6/8)	3	5.0	10.9	22.0	2.02
1900						
1050	Mod. orange (2.5YR6/8)	4	7.5	9.1	19.0	2.10
2000						
1100	Grayish reddish orange (2.5YR5/6)	5	10.0	2.9	6.9	2.34
2100						
1150	Strong brown (2.5YR4/6)	5	10.0	1.9	4.6	2.40
2200						
1200	---	---	Melted	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: ---

REMARKS: ---

POTENTIAL USES: Structural clay products (e.g., building brick at 1050-1150°C).

SNYDER COUNTY

MONROE TOWNSHIP

SUNBURY QUADRANGLE

SAMPLE NUMBER 145-D-2A

LOCATION: Shale pit operated by Carl E. Gemberling located about 1.15 miles (1.85 km) west of the Susquehanna Valley Country Club in Hummels Wharf.

LATITUDE: 40°50'16"N

LONGITUDE: 76°52'04"W

GEOLOGIC UNIT: Mahantango Formation, Devonian

DESCRIPTION: Grayish-olive (10Y4/2) to olive-gray (5Y3/2), thin-bedded and interbedded silty shale and shaly siltstone occur beneath a zone of hard siltstone beds in the quarry. The silty shale and shaly siltstone beds range from about 1 to 2 inches (3 to 5 cm) in thickness. They break to form predominantly slabby fragments mixed with a minor amount of blocky fragments. Iron and manganese staining is common along fractures and bedding planes.

ATTITUDE OF BEDDING: N70E, 38NW

WEATHERING INTENSITY: Moderate

SAMPLED INTERVAL: Channel through 12 feet (4 m) of stratigraphic section

CHEMICAL ANALYSIS:

MINERALOGY (X-RAY):

	%
SiO ₂	61.4
Al ₂ O ₃	18.40
Σ"Fe ₂ O ₃ ".....	6.76
MgO.....	1.26
CaO.....	0.37
Na ₂ O.....	0.49
K ₂ O.....	3.77
TiO ₂	1.04
MnO.....	0.036
Total	93.53

	Weight %
Quartz	18
Mica-smectite	74
Kaolinite	3
Chlorite-vermiculite	3
Feldspar	2
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 19.0
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Fair
 pH: 7.2

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (5YR7/8)	3	5.0	12.6	24.8	1.97
1900						
1050	Mod. orange (2.5YR6/8)	4	7.5	9.5	19.8	2.10
2000						
1100	Grayish orange (2.5YR5/6)	4	7.5	3.4	7.9	2.31
2100						
1150	Mod. reddish brown (2.5YR4/4)	5	7.5	2.4	5.5	2.31
2200						
1200	---	---	Melted	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: ND

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Structural clay products (e.g., building brick at 1050-1150°C).

SNYDER COUNTY

MONROE TOWNSHIP

SUNBURY QUADRANGLE

SAMPLE NUMBER 145-D-2B

LOCATION: Shale pit operated by Carl E. Gemberling located about 1.15 miles (1.85 km) west of the Susquehanna Valley Country Club in Hummels Wharf.

LATITUDE: 40°50'16"N

LONGITUDE: 76°52'04"W

GEOLOGIC UNIT: Mahantango Formation, Devonian

DESCRIPTION: Medium-gray (N5) to grayish-olive (10Y4/2), thin-bedded shaly siltstone is interbedded with a few siltstone beds in this sequence, which stratigraphically lies below sample 145-D-2A. These rocks break to form predominantly slabby fragments mixed with some blocky fragments. Iron and manganese stains are common along fractures and bedding planes.

ATTITUDE OF BEDDING: N70E, 38NW

WEATHERING INTENSITY: Moderate

SAMPLED INTERVAL: Channel through 11 feet (3 m) of stratigraphic section

CHEMICAL ANALYSIS:

MINERALOGY (X-RAY):

	%
SiO ₂	64.2
Al ₂ O ₃	17.15
Σ"Fe ₂ O ₃ ".....	6.45
MgO.....	1.26
CaO.....	0.12
Na ₂ O.....	0.80
K ₂ O.....	3.48
TiO ₂	0.96
MnO.....	0.057
Total	94.48

	Weight %
Quartz	19
Mica-smectite	72
Kaolinite	4
Chlorite-vermiculite	2
Feldspar	3
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 16.6
 Drying shrinkage (%): 2.5
 Workability: Plastic
 Dry strength: Fair
 pH: 7.1

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800 1000	Mod. orange (5YR6/8)	3	5.0	12.1	24.1	1.99
1900 1050	Mod. orange (2.5YR6/8)	4	5.0	10.5	21.6	2.06
2000 1100	Grayish reddish orange (2.5YR5/6)	5	7.5	3.7	8.5	2.31
2100 1150	Mod. reddish brown (2.5YR4/4)	5	7.5	2.2	5.1	2.34
2200 1200	---	---	Melted	---	---	---
2300 1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: ND

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Structural clay products (e.g., building brick at 1050-1150°C).

INDIVIDUAL SAMPLE DATA, SNYDER COUNTY

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SNYDER COUNTY

PERRY TOWNSHIP

DALMATIA QUADRANGLE

SAMPLE NUMBER 146-A-6

LOCATION: Inactive pit along the east side of Pa. Route 104, about 500 feet (150 m) north of the center of the village of Meiserville.

LATITUDE: 40°40'13"N

LONGITUDE: 76°58'23"W

GEOLOGIC UNIT: Devonian marine units

DESCRIPTION: Dark-yellowish-brown (10YR4/2) and grayish-red (5Y4/2), very thin to thin-bedded shaly siltstone is exposed in this pit. The maximum thickness of any bed in this sampled interval is 4 inches (10 cm). The sampled interval occurs about 70 feet (21 m) from the southern end of the exposure.

ATTITUDE OF BEDDING: N40E, 9NW

WEATHERING INTENSITY: Moderate to slight

SAMPLED INTERVAL: Channel through 15 stratigraphic feet (5 cm)

CHEMICAL ANALYSIS:

	%
SiO ₂	61.5
Al ₂ O ₃	17.90
Σ"Fe ₂ O ₃ ".....	7.55
MgO.....	1.54
CaO.....	0.16
Na ₂ O.....	0.59
K ₂ O.....	3.96
TiO ₂	1.04
MnO.....	0.086
Total	94.33

MINERALOGY (X-RAY):

	Weight %
Quartz	20
Mica-smectite	75
Kaolinite	0
Chlorite-vermiculite	2
Feldspar	3
Calcite	0

RAW PROPERTIES:

Water of plasticity (%):	17.4
Drying shrinkage (%):	2.5
Workability:	Short
Dry strength:	Fair
pH:	6.9

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (2.5YR6/8)	3	2.5	12.7	25.4	2.00
1900						
1050	Brownish orange (2.5YR5/8)	4	5.0	10.3	21.4	2.08
2000						
1100	Strong brown (2.5YR4/8)	4	7.5	6.4	14.3	2.22
2100						
1150	Strong brown (2.5YR4/4)	5	7.5	2.2	5.1	2.37
2200						
1200	Mod. reddish brown (2.5YR3/4)	5	7.5	1.1	2.6	2.39
2300						
1250	---	---	Melted	---	---	---

PYROMETRIC CONE EQUIVALENT: ND

BLOATING TEST: Negative

REMARKS: Good firing range.

POTENTIAL USES: Structural clay products (e.g., building brick, floor brick at 1050-1250°C).

SNYDER COUNTY

PERRY TOWNSHIP

DALMATIA QUADRANGLE

SAMPLE NUMBER 146-A-7A

LOCATION: Inactive shale pit about 1.2 miles (1.9 km) north-northwest of the village of Shadle.

LATITUDE: 40°43'18"N

LONGITUDE: 76°59'48"W

GEOLOGIC UNIT: Mahantango Formation, Devonian

DESCRIPTION: Olive-gray (5Y3/2) and grayish-olive (10Y4/2) shale occurs essentially as ellipsoidal forms in the upper part of this exposure. The ellipsoidal shale beds are separated from each other by thin layers of nonellipsoidal shale. Fragments from this interval are chiefly slabby; a few are chippy or platy. Iron and manganese staining is common along fractures and bedding planes.

ATTITUDE OF BEDDING: N45E, 25SE

WEATHERING INTENSITY: Moderate

SAMPLED INTERVAL: ---

CHEMICAL ANALYSIS:

	%
SiO ₂	61.5
Al ₂ O ₃	19.25
Σ"Fe ₂ O ₃ ".....	7.08
MgO.....	1.53
CaO.....	0.12
Na ₂ O.....	0.68
K ₂ O.....	3.87
TiO ₂	1.11
MnO.....	0.048
Total	95.19

MINERALOGY (X-RAY):

	Weight %
Quartz	16
Mica-smectite	78
Kaolinite	0
Chlorite-vermiculite	4
Feldspar	2
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 16.8
 Drying shrinkage (%): 0.0
 Workability: Short
 Dry strength: Fair
 pH: 6.8

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (5YR6/8)	3	2.5	14.0	27.1	1.94
1900						
1050	Mod. orange (2.5YR6/8)	3	5.0	21.7	21.7	2.06
2000						
1100	Brownish orange (2.5YR5/8)	4	7.5	7.5	16.3	2.18
2100						
1150	Strong brown (2.5YR4/6)	4	7.5	3.2	7.5	2.28
2200						
1200	Mod. reddish brown (2.5YR4/4)	5	7.5	2.2	4.9	2.31
2300						
1250	---	---	Melted	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Structural clay products (e.g., building brick, floor brick at 1100-1200°C).

SNYDER COUNTY

PERRY TOWNSHIP

DALMATIA QUADRANGLE

SAMPLE NUMBER 146-A-7B

LOCATION: Inactive shale pit about 1.2 miles (1.9 km) north-northwest of the village of Shadle.

LATITUDE: 40°43'18"N

LONGITUDE: 76°59'48"W

GEOLOGIC UNIT: Mahantango Formation, Devonian

DESCRIPTION: Dark-gray (N3), thin-bedded shale occurs stratigraphically below the shale interval represented in sample 146-A-7A. This dark-gray shale forms small splintery to platy fragments when broken. Weathered shale adjacent to fractures is commonly grayish-brown (5YR3/2). Iron and manganese staining in moderate amounts occurs along fractures and bedding planes.

ATTITUDE OF BEDDING: N45E, 25SE

WEATHERING INTENSITY: Moderate

SAMPLED INTERVAL: Composite representing 13 stratigraphic feet (4 m)

CHEMICAL ANALYSIS:

	%
SiO ₂	59.9
Al ₂ O ₃	18.80
Σ"Fe ₂ O ₃ ".....	6.76
MgO.....	1.72
CaO.....	0.07
Na ₂ O.....	0.61
K ₂ O.....	4.26
TiO ₂	0.93
MnO.....	0.022
Total	93.07

MINERALOGY (X-RAY):

	Weight %
Quartz	16
Mica-smectite	77
Kaolinite	0
Chlorite-vermiculite	5
Feldspar	2
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 15.6
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Fair
 pH: 6.6

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800 1000	Mod. orange (5YR7/6)	3	2.5	11.1	22.6	2.03
1900 1050	Mod. orange (2.5YR6/8)	3	5.0	9.1	19.1	2.10
2000 1100	Brownish orange (2.5YR5/8)	4	5.0	7.0	15.2	2.17
2100 1150	---	---	Melted	---	---	---
2200 1200	---	---	---	---	---	---
2300 1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Short firing range; abrupt vitrification between 1100 and 1150°C.

POTENTIAL USES: Marginal for structural clay products (e.g., building brick at 1100°C).

UNION COUNTY

HARTLEY TOWNSHIP

WEIKERT QUADRANGLE

SAMPLE NUMBER 125-D-1

LOCATION: Shale pit operated by Olan Boop located about 1 mile (1.6 km) east of the village of Pardee.

LATITUDE: 40°51'34"N

LONGITUDE: 77°15'06"W

GEOLOGIC UNIT: McKenzie Formation, Silurian

DESCRIPTION: Moderate-yellowish-brown (10YR5/4), dusky-yellow (5Y6/4), and light-olive-brown (5Y5/6), very thin to thin-bedded shale is interbedded with a few thin beds of siltstone. The thickest bed in this sequence is a siltstone which measures 4 inches (10 cm). Fragments of shale are predominantly platy; a minor percentage are splintery. Fragments of siltstone are slabby. Iron and manganese stains are common along fractures and bedding planes.

ATTITUDE OF BEDDING: N80E, 42S

WEATHERING INTENSITY: Severe to moderate

SAMPLED INTERVAL: Composite representing 35 stratigraphic feet (11 m)

CHEMICAL ANALYSIS:

	%
SiO ₂	64.0
Al ₂ O ₃	18.10
Σ"Fe ₂ O ₃ ".....	7.33
MgO.....	1.35
CaO.....	0.13
Na ₂ O.....	0.23
K ₂ O.....	3.90
TiO ₂	0.90
MnO.....	0.071
Total	96.01

MINERALOGY (X-RAY):

	Weight %
Quartz	18
Mica-smectite	74
Kaolinite	3
Chlorite-vermiculite	4
Feldspar	1
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 18.2
 Drying shrinkage (%): ---
 Workability: Short
 Dry strength: Fair
 pH: 7.2

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (5YR6/8)	4	5.0	12.3	24.6	2.00
1900						
1050	Mod. orange (2.5YR6/8)	4	7.5	9.3	19.5	2.11
2000						
1100	Brownish orange (2.5YR5/8)	4	7.5	6.0	13.3	2.23
2100						
1150	Strong brown (2.5YR4/6)	5	7.5	2.5	5.9	2.36
2200						
1200	Mod. reddish brown (2.5YR4/4)	5	7.5	1.5	3.5	2.38
2300						
1250	---	---	Melted	---	---	---

PYROMETRIC CONE EQUIVALENT: ND

BLOATING TEST: Negative

REMARKS: Good firing range.

POTENTIAL USES: Structural clay products (e.g., building brick, floor brick at 1000-1200°C).

UNION COUNTY HARTLEY TOWNSHIP WEIKERT QUADRANGLE
SAMPLE NUMBER 125-D-2

LOCATION: Inactive quarry located on the north side of an unimproved road about 0.3 mile (480 m) southwest of the village of Weikert.

LATITUDE: 40°51'19"N LONGITUDE: 77°18'02"W

GEOLOGIC UNIT: Rose Hill Formation, Silurian

DESCRIPTION: Grayish-orange (10YR7/4), dark-yellowish-orange (10YR6/6), and moderate-reddish-brown (10R4/6), very thin to thin-bedded shale is interbedded with a few thin beds of siltstone in this quarry. The shale breaks to form platy fragments which are relatively small sized, averaging between 2 and 3 inches (5 and 8 cm). Iron staining in moderate amounts occurs along fractures and bedding planes.

ATTITUDE OF BEDDING: N73E, 68N

WEATHERING INTENSITY: Moderate

SAMPLED INTERVAL: Composite representing 35 stratigraphic feet (11 m)

CHEMICAL ANALYSIS:	%	MINERALOGY (X-RAY):	Weight %
SiO ₂	63.5	Quartz	15
Al ₂ O ₃	19.05	Mica-smectite	84
Σ"Fe ₂ O ₃ ".....	7.56	Kaolinite	0
MgO.....	0.98	Chlorite-vermiculite	0
CaO.....	0.00	Feldspar	1
Na ₂ O.....	0.24	Calcite	0
K ₂ O.....	4.53		
TiO ₂	0.99		
MnO.....	0.060		
Total	96.91		

RAW PROPERTIES:
Water of plasticity (%): 19.6
Drying shrinkage (%): 0.0
Workability: Short
Dry strength: Fair
pH: 6.9

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (5YR6/8)	3	2.5	16.4	30.4	1.86
1900						
1050	Mod. orange (2.5YR6/8)	3	5.0	11.8	23.7	2.01
2000						
1100	Brownish orange (2.5YR5/8)	4	7.5	7.5	16.3	2.18
2100						
1150	Strong brown (2.5YR4/6)	4	10.0	3.0	7.1	2.35
2200						
1200	Mod. reddish brown (2.5YR4/4)	5	10.0	1.9	4.5	2.38
2300						
1250	---	---	Melted	---	---	---

PYROMETRIC CONE EQUIVALENT: NO BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Structural clay products (e.g., building brick at 1100-1200°C).

UNION COUNTY

HARTLEY TOWNSHIP

HARTLETON QUADRANGLE

SAMPLE NUMBER 135-A-1A

LOCATION: Shale pit operated by Charles H. Buttorff located about 2.0 miles (3.2 km) west of the village of Hartleton and about 600 feet (180 m) south of Pa. Route 45.

LATITUDE: 40°53'54"N

LONGITUDE: 77°11'53"W

GEOLOGIC UNIT: Bloomsburg Formation, Silurian

DESCRIPTION: Intensely weathered shale of the Bloomsburg Formation occurs for a minimum distance of 10 feet (3 m) below the surface. The weathered shale consists of very small particles ranging from 1.5 inches (4 cm) down to soil size. The majority of shale particles are papery fragments, suggesting they might correlate to a zone of fissile shale. The interiors of the weathered shale fragments were moderate reddish brown (10R4/6), moderate brown (5YR3/4), and moderate olive brown (5Y4/4).

ATTITUDE OF BEDDING: ---

WEATHERING INTENSITY: Severe

SAMPLED INTERVAL: Channel through 10 feet (3 m) of weathered shale

CHEMICAL ANALYSIS:

	%
SiO ₂	60.6
Al ₂ O ₃	18.75
Σ"Fe ₂ O ₃ ".....	7.28
MgO.....	1.26
CaO.....	0.06
Na ₂ O.....	0.32
K ₂ O.....	4.20
TiO ₂	0.93
MnO.....	0.078
Total	93.48

MINERALOGY (X-RAY):

	Weight %
Quartz	24
Mica-smectite	74
Kaolinite	0
Chlorite-vermiculite	1
Feldspar	1
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 19.4
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Fair
 pH: 6.3

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800 1000	Mod. orange (5YR7/6)	3	2.5	12.5	24.8	1.99
1900 1050	Mod. orange (2.5YR6/8)	3	7.5	10.1	20.9	2.08
2000 1100	Grayish reddish orange (2.5YR5/6)	5	10.0	5.1	11.5	2.27
2100 1150	Light reddish brown (10R5/4)	6	10.0	1.1	2.8	2.39
2200 1200	Mod. reddish brown (10R4/4)	6	10.0	0.8	1.8	2.41
2300 1250	---	---	Melted	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Structural clay products (e.g., building brick, floor brick at 1100-1150°C).

UNION COUNTY

HARTLEY TOWNSHIP

HARTLETON QUADRANGLE

SAMPLE NUMBER 135-A-1B

LOCATION: Shale pit operated by Charles H. Buttorff located about 2.0 miles (3.2 km) west of the village of Hartleton and about 600 feet (180 m) south of Pa. Route 45.

LATITUDE: 40°53'54"N

LONGITUDE: 77°11'53"W

GEOLOGIC UNIT: Bloomsburg Formation, Silurian

DESCRIPTION: Thin- to medium-bedded claystone and silty claystone occur under the severely weathered shale collected in sample 135-A-1A. The claystones are moderate reddish orange (10R6/6), dusky yellow (5Y6/4), dark yellow orange (10YR6/6), and moderate yellowish brown (10YR5/4). The claystones break to form blocky or slabby fragments. Iron and manganese staining is common along fractures and bedding planes.

ATTITUDE OF BEDDING: N88E, 21SW

WEATHERING INTENSITY: Moderate

SAMPLED INTERVAL: Channel through 6 feet (1.8 m) of stratigraphic section

CHEMICAL ANALYSIS:

	%
SiO ₂	61.8
Al ₂ O ₃	17.70
Σ"Fe ₂ O ₃ ".....	7.06
MgO.....	1.01
CaO.....	0.13
Na ₂ O.....	0.30
K ₂ O.....	3.88
TiO ₂	1.00
MnO.....	0.105
Total	92.98

MINERALOGY (X-RAY):

	Weight %
Quartz	30
Mica-smectite	65
Kaolinite	0
Chlorite-vermiculite	4
Feldspar	1
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 21.1
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Good
 pH: 6.4

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (5YR6/8)	3	2.5	14.1	27.0	1.91
1900						
1050	Mod. orange (2.5YR6/8)	4	7.5	11.5	22.7	1.98
2000						
1100	Grayish reddish orange (2.5YR5/6)	5	10.0	6.9	15.0	2.17
2100						
1150	Strong brown (2.5YR4/6)	6	10.0	2.4	5.6	2.35
2200						
1200	Mod. reddish brown (2.5YR4/4)	6	10.0	1.6	3.7	2.36
2300						
1250	---	---	Melted	---	---	---

PYROMETRIC CONE EQUIVALENT: ND

BLOATING TEST: Negative

REMARKS: Good firing range.

POTENTIAL USES: Structural clay products (e.g., building brick, floor brick at 1050-1200°C).

UNION COUNTY

HARTLEY TOWNSHIP

HARTLETON QUADRANGLE

SAMPLE NUMBER 135-A-2

LOCATION: Shale pit operated by Olan Boop located about 2.0 miles (3.2 km) west-northwest of the village of Hartleton.

LATITUOE: 40°54'32"N

LONGITUOE: 77°11'39"W

GEOLOGIC UNIT: Bloomsburg Formation, Silurian

DESCRIPTION: Moderate-olive-brown (5Y4/4), thickly laminated to thin-bedded shale and silty shale are exposed in this pit. The beds range in thickness from 0.2 to 2.6 inches (0.5 to 7 cm). The shales break into platy to slabby fragments. Iron and manganese staining is common along fractures and bedding planes.

ATTITUOE OF BEOOING: N75E, 70NW

WEATHERING INTENSITY: ---

SAMPLED INTERVAL: Composite representing 30 feet (9 m) of stratigraphic section

CHEMICAL ANALYSIS:		MINERALOGY (X-RAY):	
	%		Weight %
SiO ₂	62.5	Quartz	21
Al ₂ O ₃	18.50	Mica-smectite	73
Σ"Fe ₂ O ₃ ".....	7.42	Kaolinite	0
MgO.....	1.39	Chlorite-vermiculite	5
CaO.....	0.06	Feldspar	1
Na ₂ O.....	0.22	Calcite	0
K ₂ O.....	4.19		
TiO ₂	0.88	RAW PROPERTIES: Water of plasticity (%): 20.4 Drying shrinkage (%): 2.5 Workability: Short Dry strength: Fair pH: 6.5	
MnO.....	0.066		
Total	95.23		

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800 1000	Mod. orange (5YR7/8)	3	2.5	13.6	26.5	1.94
1900 1050	Mod. orange (5YR6/8)	4	5.0	10.9	22.3	2.05
2000 1100	Brownish orange (2.5YR5/8)	5	10.0	7.2	15.7	2.18
2100 1150	Light reddish brown (10R5/4)	6	10.0	1.9	4.5	2.38
2200 1200	Mod. reddish brown (10R4/4)	6	10.0	1.5	3.6	2.39
2300 1250	---	---	Melted	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Good firing range.

POTENTIAL USES: Structural clay products (e.g., building brick, floor brick at 1050-1200°C).

UNION COUNTY

LIMESTONE TOWNSHIP

MIFFLINBURG QUADRANGLE

SAMPLE NUMBER 135-B-3

LOCATION: Exposure along the east side of Pa. Route 304 about 0.50 mile (0.80 km) north-northwest of the village of Oice.

LATITUDE: 40°53'35"N

LONGITUDE: 77°02'30"W

GEOLOGIC UNIT: Bloomsburg Formation, Silurian

DESCRIPTION: Grayish-red (10R4/2), interbedded, thin-bedded shale, silty shale, and shaly siltstone are exposed for a distance of about 100 feet (30 m) along the roadway. The maximum thickness of the beds in the sequence that was sampled is 2 inches (5 cm). Fragments of shale are usually platy or hackly, whereas fragments of siltstone are slabby.

ATTITUDE OF BEDDING: N68E, 24N

WEATHERING INTENSITY: Moderate to slight

SAMPLED INTERVAL: Channel through 15 stratigraphic feet (5 m)

CHEMICAL ANALYSIS:

MINERALOGY (X-RAY):

	%		Weight %
SiO ₂	> 72	Quartz	39
Al ₂ O ₃	12.15	Mica-smectite	55
Σ"Fe ₂ O ₃ ".....	6.47	Kaolinite	0
MgO.....	1.32	Chlorite-vermiculite	3
CaO.....	0.17	Feldspar	2
Na ₂ O.....	0.51	Calcite	1
K ₂ O.....	2.77		
TiO ₂	0.98		
MnO.....	0.017		
Total	> 96.39		

RAW PROPERTIES:

Water of plasticity (%): 16.0
 Drying shrinkage (%): 0.0
 Workability: Short
 Dry strength: Fair
 pH: 6.6

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800 1000	Brownish orange (2.5YR5/8)	3	2.5	13.9	26.3	1.89
1900 1050	Brownish orange (2.5YR5/8)	3	2.5	13.0	25.0	1.92
2000 1100	Grayish reddish orange (2.5YR5/6)	3	2.5	11.4	22.5	1.98
2100 1150	Mod. reddish brown (10R4/4)	4	5.0	8.0	16.7	2.09
2200 1200	Mod. reddish brown (10R4/4)	4	5.0	5.8	12.4	2.15
2300 1250	Grayish reddish brown (10R4/2)	5	7.5	1.7	3.8	2.27

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Structural clay products (e.g., building brick, floor brick at 1150-1250°C).

UNION COUNTY

LIMESTONE TOWNSHIP

MIFFLINBURG QUADRANGLE

SAMPLE NUMBER 135-B-4

LOCATION: Exposure along the northeast side of Pa. Route 304, about 400 feet (120 m) southeast of the village of Dice.

LATITUDE: 40°53'11"N

LONGITUDE: 77°02'12"W

GEOLOGIC UNIT: Clinton Group, Silurian

DESCRIPTION: Grayish-olive (10Y4/2) to olive-gray (5Y3/2), thin-bedded shale and silty shale occur in a sequence about 200 feet (60 m) north of the southern end of the exposure. When broken, the shale forms platy fragments that are relatively small. Sandstone beds are interbedded with the shale in the northern end of this exposure and, for this reason, that portion of the section was not sampled.

ATTITUDE OF BEDDING: N59E, 22NW

WEATHERING INTENSITY: Moderate to severe

SAMPLED INTERVAL: Channel through 15 stratigraphic feet (5 m)

CHEMICAL ANALYSIS:

	%
SiO ₂	64.0
Al ₂ O ₃	18.15
Σ"Fe ₂ O ₃ ".....	7.96
MgO.....	1.69
CaO.....	0.17
Na ₂ O.....	0.36
K ₂ O.....	4.07
TiO ₂	1.00
MnO.....	0.012
Total	97.41

MINERALOGY (X-RAY):

	Weight %
Quartz	21
Mica-smectite	72
Kaolinite	2
Chlorite-vermiculite	4
Feldspar	1
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 17.0
 Drying shrinkage (%): 0.0
 Workability: Short
 Dry strength: Poor
 pH: 6.7

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (2.5YR6/8)	3	2.5	11.7	23.6	2.01
1900	Brownish orange					
1050	(2.5YR5/8)	3	5.0	10.1	21.0	2.09
2000	Grayish reddish orange					
1100	(2.5YR5/6)	4	7.5	7.0	15.4	2.18
2100	Mod. reddish brown					
1150	(10R4/4)	5	7.5	2.8	6.6	2.29
2200	Mod. reddish brown					
1200	(10R3/4)	6	7.5	1.8	4.1	2.33
2300						
1250	---	---	Melted	---	---	---

PYROMETRIC CONE EQUIVALENT: ND

8LOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Structural clay products (e.g., building brick at 1100-1200°C).

UNION COUNTY

LIMESTONE TOWNSHIP

MIFFLINBURG QUADRANGLE

SAMPLE NUMBER 135-B-5

LOCATION: Exposure along the east side of Pa. Route 104, about 2.5 miles (4.0 km) south of Mifflinburg.

LATITUDE: 40°52'43"N

LONGITUDE: 77°02'58"W

GEOLOGIC UNIT: Clinton Group, Silurian

DESCRIPTION: Light-olive-brown (5Y5/6), very thin to thin-bedded shale and silty shale are exposed at the southern end of this roadcut. The shale forms platy fragments when broken, and these are commonly less than 4 inches (10 cm) in their long dimension. The siltier beds sometimes form slabby fragments when broken.

ATTITUDE OF BEARING: N60E, 17NW

WEATHERING INTENSITY: Severe to moderate

SAMPLED INTERVAL: Channel through 15 stratigraphic feet (5 m)

CHEMICAL ANALYSIS:

	%
SiO ₂	63.2
Al ₂ O ₃	19.30
Σ"Fe ₂ O ₃ ".....	6.86
MgO.....	1.22
CaO.....	0.07
Na ₂ O.....	0.30
K ₂ O.....	4.37
TiO ₂	1.08
MnO.....	0.019
Total	96.42

MINERALOGY (X-RAY):

	Weight %
Quartz	19
Mica-smectite	79
Kaolinite	0
Chlorite-vermiculite	1
Feldspar	1
Calcite	0

RAW PROPERTIES:

Water of plasticity (%):	17.7
Drying shrinkage (%):	0.0
Workability:	Short
Ory strength:	Fair
pH:	6.6

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (5YR6/8)	3	2.5	11.6	23.5	2.03
1900						
1050	Mod. orange (2.5YR6/8)	4	5.0	9.4	20.0	2.12
2000						
1100	Brownish orange (2.5YR5/8)	4	7.5	5.8	12.9	2.24
2100						
1150	Strong brown (2.5YR4/6)	4	10.0	1.4	3.5	2.42
2200						
1200	Mod. reddish brown (2.5YR4/4)	5	10.0	0.4	0.9	2.42
2300						
1250	---	---	Melted	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Structural clay products (e.g., building brick, roofing tile at 1050-1200°C).

UNION COUNTY

KELLY TOWNSHIP

ALLENWOOD QUADRANGLE

SAMPLE NUMBER 144-C-21

LOCATION: Shale pit operated by the Milton Construction Company located about 2.0 miles (3.2 km) west of the village of West Milton.

LATITUDE: 41°01'08"N

LONGITUDE: 76°54'52"W

GEOLOGIC UNIT: Bloomsburg Formation, Silurian

DESCRIPTION: Grayish-red (10R4/2) to dark-reddish-brown (10R3/4), thick-bedded shale is exposed stratigraphically below some interbedded sandstone and shale in this pit. The thickness of the sampled shale beds ranges from about 1 to 2 feet (0.3 to 0.6 m). The shale breaks to form hackly to rubbly fragments. Iron staining is present in minor amounts along fractures in the shale.

ATTITUDE OF BEDDING: N77E, 34SE

WEATHERING INTENSITY: Slight

SAMPLED INTERVAL: Composite representing 40 feet (12 m) of stratigraphic section

CHEMICAL ANALYSIS:

	%
SiO ₂	63.5
Al ₂ O ₃	17.55
Σ"Fe ₂ O ₃ ".....	8.38
MgO.....	1.67
CaO.....	0.22
Na ₂ O.....	0.12
K ₂ O.....	5.14
TiO ₂	1.08
MnO.....	0.021
Total	97.68

MINERALOGY (X-RAY):

	Weight %
Quartz	18
Mica-smectite	80
Kaolinite	0
Chlorite-vermiculite	1
Feldspar	1
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 13.2
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Poor
 pH: 6.4

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800	Brownish orange					
1000	(2.5YR5/8)	4	2.5	7.8	17.0	2.18
1900	Brownish orange					
1050	(2.5YR5/8)	5	5.0	5.6	12.6	2.27
2000	Grayish reddish orange					
1100	(2.5YR5/6)	5	7.5	2.7	6.4	2.36
2100	Mod. reddish brown					
1150	(2.5YR4/4)	6	7.5	0.3	0.8	2.38
2200						
1200	---	---	Melted	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Good firing range.

POTENTIAL USES: Structural clay products (e.g., building brick, floor brick at 1000-1100°C).

INDIVIDUAL SAMPLE DATA, UNION COUNTY

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UNION COUNTY

WHITE DEER TOWNSHIP

ALLENWOOD QUADRANGLE

SAMPLE NUMBER 144-C-22

LOCATION: Shale pit operated by Harold Hollanbach located about 1.4 miles (2.3 km) east-southeast of the east end of Spruce Run Reservoir and about 1,000 feet (300 m) southeast of Sunrise Church.

LATITUDE: 41°01'35"N

LONGITUDE: 76°57'42"W

GEOLOGIC UNIT: Clinton Group, Silurian

DESCRIPTION: Grayish-olive (10Y4/2), very thin to thick-bedded shale and silty shale are exposed in this pit. The shale breaks to form flaggy and slabby fragments. Iron and manganese staining is common along fractures and bedding planes.

ATTITUDE OF BEDDING: N50E, 13SE

WEATHERING INTENSITY: Moderate to slight

SAMPLED INTERVAL: Channel through 10 feet (3 m) of stratigraphic section

CHEMICAL ANALYSIS:

	%
SiO ₂	59.5
Al ₂ O ₃	20.00
Σ"Fe ₂ O ₃ ".....	7.58
MgO.....	1.47
CaO.....	0.02
Na ₂ O.....	0.29
K ₂ O.....	4.67
TiO ₂	0.99
MnO.....	0.021
Total	94.54

MINERALOGY (X-RAY):

	Weight %
Quartz	16
Mica-smectite	80
Kaolinite	2
Chlorite-vermiculite	1
Feldspar	1
Calcite	0

RAW PROPERTIES:

Water of plasticity (%): 20.0
 Drying shrinkage (%): 2.5
 Workability: Short
 Dry strength: Fair
 pH: 6.4

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (5YR7/6)	3	2.5	12.6	25.0	1.99
1900						
1050	Mod. orange (2.5YR6/8)	5	7.5	8.8	19.0	2.15
2000						
1100	Grayish reddish orange (2.5YR5/6)	6	10.0	3.4	8.2	2.37
2100						
1150	Mod. reddish brown (10R4/4)	6.5	10.0	0.4	1.0	2.50
2200						
1200	---	---	Melted	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Structural clay products (e.g., building brick at 1050-1100°C).

UNION COUNTY

WHITE DEER TOWNSHIP

ALLENWOOD QUADRANGLE

SAMPLE NUMBER 144-C-23A

LOCATION: Glen Gery Corporation quarry located about 0.85 mile (1.36 km) northwest of the village of White Deer.

LATITUDE: 41°04'55"N

LONGITUDE: 76°53'35"W

GEOLOGIC UNIT: Rose Hill Formation, Clinton Group, Silurian

DESCRIPTION: Pale-reddish-brown (10R5/4), moderate-yellowish-brown (10YR5/4), and light-olive-brown (5Y5/6), thin- to medium-bedded shale of the Rose Hill Formation is being quarried for use in the manufacture of face brick. The beds range in thickness from about 1 inch (3 cm) up to about 12 inches (30 cm). The sequence includes a few interbeds of siltstone. Stockpile of shale consists predominantly of slabby fragments. Iron and manganese staining is common along fractures and bedding planes.

ATTITUDE OF BEDDING: E-W, 40S

WEATHERING INTENSITY: Moderate to severe

SAMPLE INTERVAL: Composite representing about 100 feet (30 m) of stratigraphic section

CHEMICAL ANALYSIS:

	%
SiO ₂	60.5
Al ₂ O ₃	18.25
Σ"Fe ₂ O ₃ ".....	7.58
MgO.....	1.32
CaO.....	0.05
Na ₂ O.....	0.25
K ₂ O.....	4.24
TiO ₂	0.82
MnO.....	0.052
Total	93.06

MINERALOGY (X-RAY):

	Weight %
Quartz	21
Mica-smectite	76
Kaolinite	0
Chlorite-vermiculite	2
Feldspar	1
Calcite	0

RAW PROPERTIES:

Water of plasticity (%):	18.5
Drying shrinkage (%):	2.5
Workability:	Short
Dry strength:	Fair
pH:	6.5

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800 1000	Mod. orange (5YR7/8)	3	2.5	13.2	26.1	1.98
1900 1050	Mod. orange (2.5YR6/8)	4	5.0	9.0	19.0	2.11
2000 1100	Grayish reddish orange (2.5YR5/6)	5	7.5	4.2	9.6	2.30
2100 1150	Mod. reddish brown (10R4/4)	5	7.5	1.1	2.8	2.44
2200 1200	---	---	Melted	---	---	---
2300 1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: ---

POTENTIAL USES: Structural clay products (e.g., building brick at 1050-1150°C).

INDIVIDUAL SAMPLE DATA, UNION COUNTY

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UNION COUNTY

WHITE DEER TOWNSHIP

ALLENWOOD QUADRANGLE

SAMPLE NUMBER 144-C-23B

LOCATION: Exposure north of the access road to the Watsonstown-White Deer quarry operated by the Glen Gery Corporation. The sample site is located about 200 feet (60 m) west of the chain that closes off access to the road.

LATITUDE: 41°04'48"N

LONGITUDE: 76°53'24"W

GEOLOGIC UNIT: Clinton Group, Silurian

DESCRIPTION: Medium-gray (N5) to medium-dark-gray (N4), thin- to medium-bedded and interbedded shale and limestone are exposed at this locality. The average thickness of the beds in this sequence is about 9 inches (23 cm). The shale is fossiliferous and breaks to form splintery to hackly fragments. The limestone breaks to form blocky to rubbly fragments. Iron staining is common along fractures and bedding planes.

ATTITUDE OF BEDDING: N88E, 32S

WEATHERING INTENSITY: Slight

SAMPLED INTERVAL: Channel through 10 feet (3 m) of stratigraphic section

CHEMICAL ANALYSIS:

MINERALOGY (X-RAY):

ANALYSES NOT DONE BECAUSE SAMPLE HAD NO POTENTIAL USES

SiO₂.....

Quartz

Al₂O₃.....

Mica-smectite

Σ"Fe₂O₃".....

Kaolinite

MgO.....

Chlorite-vermiculite

CaO.....

Feldspar

Na₂O.....

Calcite

K₂O.....TiO₂.....

MnO.....

Total

RAW PROPERTIES:

Water of plasticity (%): 14.7

Drying shrinkage (%): 2.5

Workability: Short

Dry strength: Poor

pH: 7.4

SLOW-FIRING TESTS:

Temp. (°F) (°C)	Color (Munsell designation)	Hardness (Mohs' scale)	Percent linear shk.	Percent absorb.	Percent app. por.	Bulk density (g/cc)
1800						
1000	Mod. orange (2.5YR6/8)	3	2.5	13.9	26.8	1.93
1900						
1050	Grayish reddish orange (2.5YR6/6)	3	5.0	13.0	25.4	1.94
2000						
1100	Grayish reddish orange (2.5YR5/6)	3	5.0	11.3	22.1	1.96
2100						
1150	---	---	Melted	---	---	---
2200						
1200	---	---	---	---	---	---
2300						
1250	---	---	---	---	---	---

PYROMETRIC CONE EQUIVALENT: NO

BLOATING TEST: Negative

REMARKS: Abrupt vitrification between 1100 and 1150°C.

POTENTIAL USES: Not suitable for structural clay products.

CORRELATION OF GEOLOGIC UNITS AND USES

GENERAL STATEMENT

The test results from the 143 samples were used as a basis for correlations between geologic units and preliminary use evaluations. From a practical standpoint, a geologic unit that has a relatively high percent of samples indicated as potentially suitable as raw material for a particular use might warrant consideration as an exploration target. The geologic units referred to in this report are those identified in the legend of the geologic map (Plate 1). Each unit consists of either a geologic group, a formation, a combination of formations, or, as in one case, a combination of marine beds (Devonian marine). By keying from the legend of the geologic map in Plate 1, it is possible to define the places in south-central Pennsylvania where a geologic unit of interest is present at or near the surface. In most cases, the accurate location of any subdivision within a geologic unit will require field examination.

The percent of the total number of samples suitable for each use is shown graphically in Figure 4. To illustrate, 66 percent of the 143 samples met the test criteria for use as raw material for building brick, whereas only 4 percent of the samples tested satisfactorily for use in the production of marginal lightweight aggregate.

EXPLORATION TARGETS

General Statement

The number of samples indicated as potentially suitable for each use from 14 different geologic units appears in Table 10. Numbers shown in bold type identify the units considered to be the best exploration targets for each use in south-central Pennsylvania. The use indications are based on preliminary evaluations. They may differ from results that would be achieved in a full-scale commercial operation. They also do not preclude additional uses when blended with other clay materials. To be included as an exploration target, the geologic unit had to be represented by a minimum of three samples.

For refractories and lightweight aggregate, the units showing the highest combined percents for the different subdivisions under these two uses were selected as exploration targets.

Building Brick

The four geologic units showing higher-than-average percents for building brick are: (1) Devonian marine beds (undifferentiated); (2) Bloomsburg Formation; (3) Clinton Group, including the Rose Hill Formation; (4) the Marcellus Formation in the Hamilton Group. The percent of samples from the Freeport Formation in the Allegheny Group and the Mahantango For-

BRICK			TILE			REFRACTORIES		LIGHTWEIGHT AGGREGATE		WHITE-WARE	SANITARY-WARE
Building	Facing	Floor	Structural	Facing	Roofing	Low Duty	Medium Duty	Marginal	Promising		



Figure 4. Percent of the total number of samples (143) suitable for each use.

mation in the Hamilton Group that tested satisfactorily for raw material for building brick exceeded the average 66 percent achieved for all 143 samples.

Facing Brick

Five geologic units exceed by a factor of at least two the 21 percent average for all 143 samples as sources for raw material for the manufacture of facing brick and are considered to be good exploration targets. They are: (1) the Catskill Formation; (2) the Harrell Formation; (3) the Trimmers Rock Formation; (4) undifferentiated Trimmers Rock and Brallier Formations; and (5) the undifferentiated Hamilton Group. The Harrell, Trimmers Rock, and Brallier Formations are all included in the Devonian marine beds.

Floor Brick

The best exploration target for floor brick is the Bloomsburg Formation, for which 50 percent of the samples satisfied the test criteria. Other geologic units that exceeded the 12.6 percent average for all 143 samples were: (1) the

	Hamilton	(undifferentiated)	3		3															
		Mahantango	31	22	8	3			1						3					
		Marcellus	25	20	2	1									2					
Silurian		Bloomsburg	10	9	1	5														
		McKenzie	1	1		1														
	Clinton	(undifferentiated)	9	8		1			1											
		Rose Hill	5	4		1														
Ordovician		Reedsville	16	9	2			1							1	2				
		Bellefonte and Axemann	1	1		1														
Cambrian		Gatesburg	5			1	3								2	1		1	1	
All samples			143	95	30	18	3	3	2	2	1	7	2	1	1	2	1	1	1	

*Refer to explanation on Plate 1

Freeport Formation within the Allegheny Group; (2) the Catskill Formation; (3) the Rose Hill Formation in the Clinton Group; and (4) the Gatesburg Formation.

Structural Tile

The only geologic unit to show a potential for structural tile is the Gatesburg Formation. The type of raw materials collected and tested from the Gatesburg Formation were residual white clays that had been derived from silty dolomite through the processes of weathering.

Facing Tile

The Freeport Formation in the Allegheny Group and the Reedsville Formation are the only geologic units from which samples tested satisfactorily for facing tile. Based upon the percent of samples to meet specifications as shown in Table 10, the Freeport Formation is regarded as the better target.

Roofing Tile

Only one sample from the Clinton Group and one from the Mahantango Formation in the Hamilton Group tested satisfactorily for roofing tile. Because of the low percent of success shown for both geologic units in Table 10, neither is classified as a good exploration target.

Refractories

The Gatesburg Formation is the only geologic unit to show a potential for refractories in Table 10, and is classified as a good exploration target. The type of raw material collected for test purposes from the Gatesburg Formation was residual white clay that had been derived from silty dolomites through the processes of weathering. Such deposits would not be expected to have the lateral extent of a shale formation.

Lightweight Aggregate

The only geologic unit to have samples (two) test satisfactorily for promising lightweight aggregate is the Reedsville Formation, and it is therefore considered to be the only exploration target for this use.

Sanitaryware and Whiteware

A sample from the Gatesburg Formation is the only sample to show a potential for whiteware and sanitaryware, and the Gatesburg is classified as an exploration target for these uses. The type of material collected from the

Gatesburg Formation for testing was residual white clay derived from weathered silty dolomite.

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- REEDSVILLE FORMATION**
Medium to dark gray, fine shale at base, grading upward into olive-gray, thin-bedded shale containing thin interbeds of siltstone, sandstone, and fossiliferous limestone. Black shale of Antio Member at the base.
- MISSISSIPPIAN**
- MAUCH CHUKK FORMATION**
Grayish red sandstone and siltstone and grayish-brown sandstone, locally conglomeratic.
- POCONO GROUP**
Predominantly gray, hard, massive cross-bedded conglomerate and sandstone containing thin blue beds.
- DEVONIAN**
- CATSKILL FORMATION**
Gray and medium gray shale, claystone, siltstone, and sandstone.
- MARINE BEDS**
Olive-gray shale, siltstone, and minor sandstone; includes the Butler Formation, the Harell Formation (consists of the Butler, Shale Member), and the Tremont Rock Formation.
- MAHANTANGO FORMATION**
Olive-gray shale and interbedded sandstone.
- MARCELLUS FORMATION**
Black, fossiliferous, carbonaceous shale containing minor sandstone in places.
- ONONDAGA FORMATION**
Gray, thin-bedded shale in lower portion, becoming dark gray to medium gray, medium-bedded limestone in upper portion (fossiliferous). Includes Tringa bentonite at top.
- ORISKANY FORMATION¹**
White to brown, fine to coarse-grained, partly calcareous sandstone at top, at bottom, dark-gray cherty limestone having interbedded shale and sandstone, residual white to gray clay, at bottom, residual white to gray clay.
- HELDREBERG FORMATION¹**
Dark gray, calcareous, thin-bedded shale at top, dark gray, cherty, fossiliferous limestone containing local sandstone in middle, dark gray, medium-bedded limestone at bottom.
- SILURIAN**
- KEYSER FORMATION**
Gray, fossiliferous, cobbly or nodular limestone. (The Silurian-Devonian boundary is within the Keyser.)
- TONGLOUGH FORMATION**
Gray, laminated to thin-bedded, argillaceous limestone.
- WILLS CREEK FORMATION**
Light-gray, greenish-gray, and grayish-red, thin and thick, cross-bedded calcareous shale and siltstone, and local units of sandstone and thin limestone; some greenish shale.
- BLOOMSBURG FORMATION**
Grayish-red claystone, shale, siltstone, and sandstone, local units of thin impure limestone; some greenish shale.
- McKENZIE FORMATION¹**
Greenish-gray, thin-bedded shale interbedded with gray, thin-bedded, fossiliferous limestone.
- CLINTON GROUP**
Predominantly fine Hill Formation, consisting of olive to medium-gray, thin-bedded shale containing interbeds of grayish-red to purple shale, olive-gray siltstone, and fine-grained sandstone; several highly ferruginous sandstones locally. Above Rose Hill are brown to white Keeler sandstone and shale to thin-bedded Rochester shale.
- TUSCARORA FORMATION**
White to gray, medium to thick-bedded, fine-grained quartzitic sandstone and thin interbeds of gray, thin-bedded shale.

- COBURN FORMATION**
Dark gray to black, thin-bedded limestone and interbeds of black shale.
- SALONA FORMATION**
Dark gray, thin bedded, dense limestone.
- NEALMONT FORMATION**
Bluish-gray, fairly crystalline, fossiliferous limestone, lower part grades laterally into Curtin Formation.
- CURTIN FORMATION**
Gray impure limestone, bluish-gray, fine grained, high-calcium limestone (Valentine Member [1911]).
- BENNER FORMATION**
Gray, mottled, dolomitic limestone and coarse granular limestone.
- HATTER FORMATION**
Dark gray, impure, fossiliferous limestone.
- LOYSBURG FORMATION**
Dense limestone, gray, irregularly bedded dolomitic limestone.
- BELLEPOINTE FORMATION**
Gray, even to fine weathering, mostly unbedded, dense dolomite.
- ANEMANN FORMATION**
Bluish-gray, medium-bedded, dense, fossiliferous limestone abundant in many areas.
- NITTANY FORMATION**
Gray, thick bedded, coarsely crystalline dolomite.
- STONEHENGE/LARKE FORMATION**
Si onchager bluish-gray and dark gray, finely crystalline limestone, some laminar. Lack of dark gray, coarsely crystalline, dolomite, lateral equivalent of Stonehenge to the south.
- BERKSHIRE TOWN GROUP**

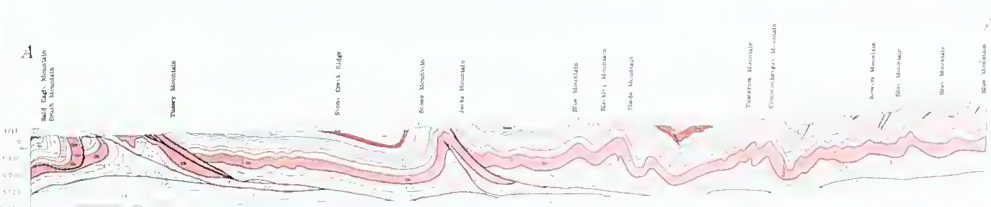
- SYMBOLS**
- Geologic contact
Inclined; equivalent to local red and red mud contact
- Fault
Dashed white line
- Location where clay shale sample was obtained, and sample number



GEOLOGIC MAP SHOWING LOCATIONS OF CLAY-SHALE SAMPLE SITES
IN SOUTH-CENTRAL PENNSYLVANIA

BY
BERNARD J. O'NEILL, JR., AND JOHN H. BARNES
1981

CROSS SECTION
(Horizontal scale same as map scale, no vertical exaggeration)



¹For the currently accepted maps for the Onondaga, Heldreberg, and McKenzie, see also Fall and Wells (1974).

New map from Pennsylvania Geological Survey, 1981, and others, 1980. Based on Fall and Wells (1974). Copyright 1981 by Commonwealth of Pennsylvania.

James H. Lingle and Gary L. Bates, Cartographers.

